Science Education

Formerly GENERAL SCIENCE QUARTERLY

Devoted to the Teaching of Science in Elementary Schools, Junior and Senior High Schools, Colleges and Teacher Training Institutions

Volume 25 **APRIL, 1941** **Number 4**

Contents

(The Contents of SCIENCE EDUCATION are indexed in the Educational Index)

Symposium: Desirable Contributions of Science in General Education to the Democratic Way of Life.....*Harlan True Stetson Oscar Riddle, Leonard Carmichael, W. F. G. Swann, Elliot R. Downing, George A. Baitsell,* and *Hanor A. Webb*..... 181
Needed Research in Science Education.....*A. N. Zechiel* 195
An Evaluation of Broadcasts and Recordings for the Science Classroom.... *J. Robert Miles* 200
Goals in the Physical Science Survey.....*Morris Goran* 206
A Method of Determining the Value of Junior High School Science Courses.....*G. M. Relyea* 208
A Study of the Grades of the West Virginia University First-Year Physics Students with Reference to Previous Training in High-School Physics.....*James Earl Rudy* 210
Status of Nebraska Science Teachers.....*Wayne Nicholls* 213
A Study of a Microprojector as a Teaching Aid.....*Edith Brechbill* 215
The Fifty-Five Minute Class Period for General Science..*G. M. Rawlins, Jr.* 219
Editorials and Educational News..... 222
Abstracts..... 227
Book Reviews..... 231

PUBLISHED BY
SCIENCE EDUCATION, INCORPORATED

Communications regarding manuscripts should be sent to the Editor, Science Education, 374 Broadway, Albany, N. Y., or 32 Washington Place, New York City. Major articles should be no longer than 3,000 words; classroom notes should be limited to 500 words. "Suggestions to Authors" will be sent upon request.

Correspondence regarding advertising, subscriptions and business matters should be addressed to the Business Manager, Science Education, College Station, Stillwater, Oklahoma. The subscription price is $2.50 a year; $3.50 in Canada and other foreign countries. Single copies are 50 cents; 65 cents in foreign countries. Prices on back numbers will be sent on request. Prices on reprints of articles are available to authors.

4 GREAT NEW BOOKS *just published by* McGRAW-HILL

1. *THE EARTH AND ITS RESOURCES*

By Finch, Trewartha and Shearer. Just out! An absorbing account of our natural environment which ably acquaints students with its influence on life. It covers both physical and economic geography with emphasis on the conservation of natural resources. In clear, comprehensible vocabulary, the authors explain the relation of the earth to the other planets, the moon and sun; systems of measurement used by man in his study of the earth; the atmosphere—its temperature, pressure, winds, moisture, storms, and principle types of climate; the solid earth—its composition and relief features; the oceans and their shores. Finally the book treats the natural resources of the earth, closing with a brief discussion of the major geographical regions of the U. S., their natural resources, climate, soils and economic products. $2.40.

2. *TOURS THROUGH THE WORLD OF SCIENCE*

A General Science Text Book by Wm. T. Skilling. New 1941 edition. Thoroughly revised to keep abreast of modern developments this elementary text, presenting the 8th or 9th grade course in general science in clear, nontechnical language, more than ever meets the demand for teaching the scientific method and spirit. Proper material from many fields is successfully organized into a balanced treatment of the physical and biological aspects of science. Interest is cultivated by a fictional tour of the science world. New material explains aviation progress, conservation developments, planetariums, atoms, metals and alloys, automotive advances, electric power and transmission, short-wave telephoning, television, world's largest telescope, vitamins, etc. $1.70.

3. *MATERIALS OF INDUSTRY*

Their Distribution and Production, by S. F. Mersereau. New third edition. This book gives students real understanding of the basic materials and processes used in modern industry. It supplies the experiential background needed by all students who are preparing for shop work, for the trades and for science courses. Through it the student is given an interesting picture of the sources, methods of production, and uses of such basic materials as forest products, non-metallic minerals, iron and steel, non-ferrous minerals, rubber, and synthetic materials. Up to the minute, in line with latest developments in industry. A new chapter on plastics, new illustrations, helpful teaching aids, etc., are some of the outstanding features. $2.00.

4. *UNDERSTANDING RADIO*

By Watson, Welch and Eby. Just out! Covers the radio field for the newcomer who knows nothing about radio and little about electricity, giving the student sufficient working acquaintance with radio principles and operation to understand current radio literature. In easily understood terms, it describes basic radio circuits and principles from wave motion through both a-c and d-c tubes and their use in basic receiving circuits, and power supplies and speakers. $2.80.

Write for further information

McGRAW-HILL BOOK COMPANY, INC.

330 West 42nd Street, New York

Science Education

SYMPOSIUM: DESIRABLE CONTRIBUTIONS OF SCIENCE IN GENERAL EDUCATION TO THE DEMOCRATIC WAY OF LIFE

FOREWORD

In these days when the democratic way of life is being challenged from several directions, teachers find it imperative to give serious consideration to the contributions which their leadership and guidance can make to a proper vision by youth of critical thinking and cooperative, tolerant action. So close is the parallel between scientific problem solving and the true democratic way of meeting the problems of personal and social living, that teachers of science have a special responsibility to inculcate in our youth the desirable scientific attitudes, the conscious techniques of scientific procedure and the scientific knowledges which preclude bias and prejudice and ignorance in arriving at choice in human behaviors.

With this thesis in mind, the editor has asked a number of leaders in the fields of science and science education to formulate statements for a written symposium on the subject designated in the title above. In order to direct the statements in the symposium toward a single, major purpose, the editor included in his request the following paragraphs:

The frame of reference which I have in mind for the symposium is this. Science, conceived as attitude, method, and knowledge, has contributed, and will continue to contribute, significant effects upon the cultural ideas, intelligent adjustments and liberalizing ideals of our citizens. Our ways of daily living and our ideals of critical thinking, personal philosophy of life, health, comfort, efficiency, safety, conservation, consumership, and social life in general are being interpreted and modified by the implications and applications of science, broadly conceived. Accordingly, the human problems of individual and social interaction with the environment are ever new and challenging. Teachers of science in general education, if their own education is to be functional and if their leadership of youth is to be realizing, must have a broader and saner perspective of the place of science in the work and progress of the world and of the potentialities of science in the improvement or the impairment of a democratic society.

You can assist teachers of science to a richer vision of their responsibilities by your contribution directed to some aspect of the topic or to the whole topic.

We are deeply grateful for the privilege of publishing here the varied points of view of seven leaders in the fields of science and science education. To these men who have contributed so willingly of their time and experience we extend our thanks on behalf of our readers.

I

There is increasing evidence that scientists and all others concerned with its advancement are beginning acutely to be conscious of the social implications of science and its relation to our democratic institutions. At the Secretaries' Conference held in connection with the Philadelphia meeting of the American Association for the Advancement of Science last December, there was a discussion on science and democracy. Representatives of the Association discoursed on such subjects as: how organized science has helped democracy; how organized science has hindered democracy; and, practical steps to improve the contributions of science to democracy. That science through its attitude, method and accumulating knowledge has contributed and will continue to contribute to our democratic way of life is a belief that most intelligent people will not challenge. The misuse of scientific inven-

tions and the lack of the scientific approach to many problems of society and of nations is, however, a challenge to those of us who feel responsibility in the education of scientific ideas and scientific ideals.

The critical times in which we find ourselves call for clear and careful thinking as to how we may more effectively utilize the methods of science for the amelioration of misunderstandings and difficulties in the social order of the world. We are living in an age so characterized by inventions that it has often been called the age of science. We all make use of the convenience that science has created, and science has so perfected its gadgets that the most untechnical can operate the complicated mechanisms of motor cars and tune their radios to desired programs without the slightest thought of the basic principle of physics underlying their use.

It is deplorable but neverthless factual that contrivances originally created for the benefit of mankind and the lessening of his labors can be turned to his own destruction. Radio communication, airplanes, motorized vehicles, high explosives—all ostensibly useful as servants of mankind—when turned to its destruction threaten that life and spirit of democracy which gave the opportunities for their creation.

While scientific advisory bodies convene to help in our own problems of national defense through the creation of new ingenious methods and devices for mitigating the evils of scientific inventions, turned to destructive use, we are faced with a larger and more significant problem—the problem of disseminating the spirit of science which has worked relentlessly for the betterment of mankind. This is the process of scientific education in its largest aspect.

We have passed swiftly through decades of the conquest of the physical world through countless research in scientific laboratories. All too slowly, perhaps, has the spirit of scientific inquiry and the application of scientific principles been directed to the problems of human nature within the individual and within the masses. Through countless curricula we have taught the principles of physics and chemistry and of technology to thousands upon thousands of youth. Yet the presentation of the facts of science seem to have made little impression in the application of the principles of science to human relationships and individual endeavor. Too largely are the problems of living decided on the basis of emotional appeal rather upon the gathering of facts and rational deductions made therefrom.

When one reads the story of science as the evolution of ideas and the struggle of man in his search for a better knowledge of the universe rather than a compilation of laws, formulae and technical data, we can perhaps anticipate a more serious impact of science upon our way of living. Education is a slow and tedious process, yet if science is to help solve the serious ills of the world today, it would appear that we must seek a new emphasis for infiltrating the spirit of science throughout the whole field of general education.

Too long, perhaps, in our teaching of history we have glorified military heroes at the expense of the appreciation of leaders in art, literature and scientific achievement. Even in the teaching of our science all too frequently courses in chemistry have been taught to make chemists, botany to make botanists, and technology to make technicians, even in those introductory courses where not one in a thousand could expect to become expert in any scientific subject. To reveal through the narrative of science, however, the slow and tedious process of trial and error in man's approach to the physical universe is one of the most liberalizing influences that can be injected into our educational system. Scientific ideas are discerned to be right insofar as they are consistent with observed facts, and wrong insofar as they show inconsistencies with observations. The Ptolemaic astronomy of yesterday with its geocentric universe was not wholly wrong. It was

right insofar as it was consistent with observations limited in accuracy and with ideas of a universe of very limited dimensions. We still make use of geocentric conceptions in problems of surveying and of navigation. It was with the refinements of observations making possible an increasing array of data that necessitated the acceptance of the heliocentric theory for explaining planetary motions. With the evolution of experimental science came the conception of a universal orderliness and the irrationality of caprice. Science leaves no fertile territory for superstition, prejudice or intolerance. If we teach such basic conceptions, whether we are teaching astronomy, geology, physics, or chemistry, such conceptions quite unconsciously must ultimately have their effect on rationalizing thinking.

I am well aware that many orientation courses are in progress to convey the spirit of evolution of ideas as well as the evolution of the material universe, but cannot more emphasis be placed on the human side of science in the earliest course in our preparatory school curricula? If the elementary school pupil were to learn the fundamental facts of nature as the unfolding of a detective story in which scientific men of genius were Sherlock Holmeses, the spirit of science might be caught more readily than through the memorization of chemical formulae and dehumanized laws. When one finds a science requirement in the curriculum irritating to a pupil who makes daily use of the radio, the telephone, the automobile and other devices of science and engineering, one cannot but wonder where the fault lies. When scientific achievement and the story of men who have pushed back the barriers of knowledge have been given renewed emphasis, then perhaps a greater proportion of would-be hero-worshippers among our youth will come from science's Hall of Fame. If a little more than two decades are needed to train for military purposes a new generation, then the same amount of time spent in an organized effort for education in a scientific attitude of mind ought to work wonders. The earliest years are the formative ones and the scientific method of approach in the solution of problems of adjustment of the individual and society should form the effective background upon which a more intelligent perspective would later be based.

It is my belief, then, that a new emphasis in educational curricula together with a further and ever extending popularization of science among the reading public will prove an effective contribution towards the persistence and security of democracy. Science knows no race, creed, or national supremacy. It is a common field for investigation of all peoples. It is science which offers new frontiers for exploration after all territories of the globe have become discovered and colonized. The spirit and the method of science as applied to the solution of international problems must be a firm plank in any future basis for world peace. Only where freedom of initiative and freedom of expression is unconstrained can the spirit of science thrive. If science thrives, it will demand such freedom.

It is significant that at the closing meeting of the Council of the American Association for the Advancement of Science in Philadelphia, a resolution was passed inviting the cooperation of the British Association for the Advancement of Science in helping to phrase a charter of democracy upon scientific principles and that the response of the British Association was immediate in wishing to join in such an endeavor. For any democracy that is worthy of the name, the spirit of science and the principles of science must be basic in its foundation. The teaching of such principles can be education's contribution to democracy.

Harlan True Stetson
Research Associate
Massachusetts Institute
of Technology
Cambridge, Mass.

II

It is chiefly through science that some out of many savage human tribes have been lifted to their actual state of civilization and thus given opportunity to choose between the democratic and another way of life; but in no true sense has science yet entered into the general education of any generation of man anywhere. Till now only the action of diluted science given in homeopathic doses to a fraction of a people is recordable as history.

Through a few such simple scientific triumphs as the making, preservation and utilization of fire, and the discovery, planting and harvest of a cereal grain, roving bands of graduate apes were enabled to establish permanent homes—larger communities in which, in favorable climates, both labor and leisure were assured. Wheels and boats now carry us from place to place, but their predecessors were bridges between long isolated communities and therefore cradles for civilized life. Steam, electricity and their offspring have recast the pattern of community life in all civilized nations, multiplied greatly the possible population density of nations, provided many of us with occupations, brought much leisure to most men and determined the trade routes of nearly all of the modern world. By-products of the civilization created and spread by science are innumerable—and some of these, like some men, are neither desirable nor good.

To date, however, the greatest failure of science is to win for itself its proper place in the general education of any community or nation. Its chief effects on our physical selves and our physical environment have been produced without either the knowledge or manifest consent of the masses of men. Equally great and desirable effects on our mental selves would result from early, adequate and universal training in the methods and principles of science. Modern science has supplied basic information concerning our own nature and the nature of the world in which we live; but, though an age-long persistence of a democratic society would seem to depend upon this, the educational program of no community or nation has succeeded hitherto in transmitting that information and understanding to a majority of its people. The three following generalizations of modern science would seem to constitute a minimum for guarding personal, community and racial health and for providing a common basic agreement concerning the real foundations for the ordinance and law which may be successfully applied to growing aggregations of men: 1. Natural (not supernatural) law rules in the world about us. 2. Man is a higher animal. 3. All men (except identical twins) are created genetically and biologically *un*equal.

The above-named principles clearly involve a great deal of biological science. It is also clear that no youth will assimilate and possess those three principles as the result of a slight exposure to the subject, and evident also that only a well-trained teacher can teach this subject successfully. If such study and teaching are desirable ends the educational authorities of our own democracy still need to create some of the machinery through which they may be attained. The curriculum of secondary schools in the United States does not grant the pupil the time necessary for such study, and fewer than half of the biology teachers in those schools are sufficiently trained in biology to give acceptable instruction in this subject or in these principles.

The democratic way of life should be more easily and more surely maintained by a nation which can minimize deep-seated diversities, animosities and antithetic convictions of its population. In some degree all of this is done through the leveling of thought that comes with approach to reality; partly too, as in the case of racial and individual differences, emotional reactions tend to flatten under the cool calcula-

tion of understanding—if understanding is available. History indicates that religion, race and nationality or plunder are the more common sources of strife and war. Far-reaching effects of widespread scientific knowledge involve the slow erasure of troublesome religious difference, and an understanding of the biological nature and origin of racial difference should tend to make that difference more natural and acceptable; again, the story of science should greatly increase a sense of brotherhood among men, and surely it stresses the heartening truth that the things which men and nations have created and can create are immensely more valuable than anything they have ever stolen.

Democratic peoples should know, as biologists now know, that medicine, philanthropy and charity and governmental agencies are preserving many genetically unfit human beings to an extent which, if unchecked, must result in deterioration of the human race. These well-meaning humanitarian forces now not only circumvent nature's formula for removing the unfit but they provide an ever-increasing reservoir of heritable human weakness. If the race is to escape this slow enfeeblement all of the people of a democracy should become familiar with the facts that must be dealt with, and they must attain that now absent degree of mental emancipation that will enable them to take the measures necessary for the preservation of the physical and mental strength of our race. Our reliance for success here, as elsewhere, must be upon science and the method of science as these can be made widely known through the schools. Men may as well make up their minds that neither magic, tea-leaf reading, nor prayer will suffice for checking this slow deterioration of the race.

The democratic way of life is now threatened and in the future will become increasingly imperiled by the widespread failure of peoples to recognize frankly the biologic and genetic *in*equalities of human beings. Our own and other democracies make only the mildest concessions to this principle, while labor unions and some other native institutions largely defy and deny this reality. To this writer it seems quite possible that the majority of any democratic population will need clearly to understand the biologic inequality of men if their democracy is long to survive, and quite probable that those true democracies which fail to understand and accept this reality will drift temporarily into communism. Only biologic truth spread widely by the general education of peoples can safeguard the democratic way of life from this threat.

From the store of biological truth we cite one further item of value to those democratic peoples who cherish the easy life. Perhaps man needs and will ever need an antidote for his urge to inaction, and ever more so under those satisfying forms of government which give him abundant leisure. It is obvious that the higher, more developed and more successful animals are much on the move—fishes, reptiles, birds, mammals. Just below the fishes in the ladder of evolution, however, is a small group of animals—the Ascidians—which adopted an exclusively sedentary life; they refuse even to float in the surging oceans in which they live. These ancient forms have had much time in which to change, expand, meet and challenge their rich and boundless environment. Actually, however, we now find that to the layman the two ends of their acorn-sized bodies are not easily recognizable as head or tail, and that even their heart pumps blood alternately in one direction and then in the other. Yes, a knowledge of that highest phylum of animals—the one to which we ourselves belong—includes good evidence that effort and struggle have been useful in the long evolutional marches which led to man. Perhaps the members of a really successful democratic society will need to know and value the premiums which nature places on effort and the prices she exacts for sloth.

Shall the public that must now decide and must later guard the fate of our democracy conceive nature and man as scientific investigation discloses them or as uninformed and essentially ignorant masses can variously imagine them? In some laboratories of the world—chiefly in Europe and America—the researches of much less than a century have shown that such things as mosquitoes, flies and lice may and do carry pain, disease, poverty and death to human beings. Enlightened thought and practice in many parts of the world now strive to exterminate these pests and thus advance the welfare of human beings; but some five years ago Mohandas K. Gandhi—who alone largely controls the destiny of one-eighth of mankind—seems to have said: "We have no right to take the lives of mosquitoes, flies, lice, rats or fleas. They have as much right to live as we." Every biologist recognizes that the two largest aggregations of men—politically impotent in China and India—are much more restrained and impoverished by ignorance of simple biological law than by any deficiency in letters, arithmetic or the rules of trade. But the Gandhis are everywhere—they are your neighbors and mine—and they thrive and propagate in a dim educational twilight from which the thought-transforming light of new knowledge is very largely excluded. Today nations and peoples may choose, on the one hand, between the host of unrealities, poverties and diseases rooted in meditations, prayer, crystal-gazing and traditional ignorance; on the other hand, through full and earnest teaching of science in their schools their destiny can accord with the realities already disclosed and in continuous process of disclosure by scientific research. An increased emphasis upon the method and contributions of science in the general education of a nation provides one means—probably an essential means—of safeguarding the democratic way of life.

OSCAR RIDDLE
Carnegie Institution of Washington Station for Experimental Evolution Cold Spring Harbor, L. I., N. Y.

III

Psychology has much to contribute to general education and to an understanding of the democratic way of life because it is one connecting link between the biological sciences and the social sciences. The so-called "technical checklist" in psychology recently developed by the National Roster of Scientific and Specialized Personnel for the national government breaks down the field of psychology into the following general headings: general and experimental psychology; the learning processes in animals and men, including motivation; physiological psychology; social psychology; abnormal psychology; educational psychology; psychometrics; applied psychology; the psychology of individual differences.

This analysis of scientific psychology is still further subdivided in this checklist in relation to what America's psychologists are actually doing. Thus certain psychologists are listed as experts in the field of animal motivation and the function of the sense organs of animals; other psychologists concern themselves with the relationship between brain localization and psychological phenomena. Men who specialize in these fields just enumerated for the most part are biologically trained and have developed the techniques of the biological sciences in connection with the solution of special psychological problems.

In the field of social psychology, on the other hand, the professional psychologist turns to problems and techniques which are much more closely allied to those of the sociologist and of the economist than to the natural scientist, but even in these fields the psychologist is unique. He never

forgets that he is always dealing, even in social situations, with a living organism in an environment. When the social psychologist concerns himself with problems such as the nature of attitudes and their measurement, crowd behavior, characteristics of leadership, and the nature of propaganda and suggestion he always remembers that he is dealing with human individuals who have human brains and human endocrines.

The field of abnormal psychology also is closely related to the social sciences and in addition to the medical sciences. Certain aspects of abnormal psychology in America are considered as the province of the medical psychologist or psychiatrist rather than of the general human psychologist, but in many problems involving mental health and disease psychiatrists and psychologists cooperate. Here the psychologist is especially interested in the cause, nature, and social implications of mental difficulties. Psychologists are also often concerned with procedures by means of which mental health may be maintained.

The field of educational psychology is one of the principal applied fields of psychology. Here child psychology and the psychological processes involved in instruction in special subjects in the schoolroom are considered. Of course educational psychology in its fundamentals depends upon an understanding of the basic characteristics of the learning process. The basic laws of learning in many cases have been demonstrated to hold in the case of man and the higher animals as well. Hence in this field animal psychology has made some of its most fundamental contributions.

The relatively new field of psychometrics is one in which the psychologist interests himself in the construction of questionnaires and in the evaluation of the results secured from questionnaires and tests as well as from materials collected by interviewing, public opinion polls, and the like. Classical psychometrics dealt with what is called psychophysics, that is, the study of the definite quantitative relationship between alterations in a physical stimulus acting upon an organism and the reactions of that organism to the stimulus. The field of psychophysics is one in which remarkable advances have been made and in which detailed application is today possible. Many procedures in optics, acoustics, and the like are really to be considered as evidences of fundamental techniques first worked out by psychologists who specialized in the field of the psychophysical method.

The present national emergency once again emphasizes the tremendous importance of test construction and test application in providing techniques by means of which large groups of men may be rapidly and effectively sorted. Dr. Walter Van Dyke Bingham, working in the Adjutant General's office, has been able to devise a series of new measures which are proving effective in the present emergency in bringing about proper classification of recruits who come to the Army as a result of the operations of the Selective Service Act.

The term "applied psychology" is used to cover a wide range of topics in which psychological principles are used in everyday life. The psychology of advertising, the psychological aspects of the selection of truck drivers and pilots, and the like, are examples in this field. Under this heading also fall general studies of efficiency and fatigue, of industrial management, and the personnel factors in commerce. The field of applied psychology is based upon the study of individual differences in mental life. In almost every applied psychological situation the question that is asked may be formulated as follows: How does this individual before me compare with individuals already known concerning this particular task which must be accomplished? Thus tests which give an indication of certain general aptitudes which are commonly called intelligence are of the greaest importance in education and in industry. Similarly, measurement of motor skills,

personality, emotion, and so forth, are significant but by no means infallible guides in finding the right man for any particular occupation.

What has been said above indicates that the bulk of the work done in modern psychology is factual and experimental. A few psychologists still professionally interest themselves in systematic or philosophical formulations of the whole field of psychology, but by and large these individuals, though they make definite contributions to the field of psychology, are now outnumbered by an army of scientific workers who attempt to develop the detailed laws of the new humanism. These laws concern themselves with human reactions in various situations. It only requires an emergency such as the present to bring to the fore the importance of considering men not in a general and abstract sense but as particular individuals with particular psychological characteristics.

LEONARD CARMICHAEL
President, Tufts College
Director, National Roster of Scientific and Specialized Personnel.
Medford, Mass.

IV

In the case of the growth of any subject such as the teaching of physics over a long period, certain avenues of procedure are apt to become developed with such solidity that departure from them becomes almost unthinkable to those whose lives have been spent in conventional teaching. These avenues have been determined by many considerations, some of which are really prejudicial to the goal ultimately sought. The apparent necessity of providing tests of progress in the cases of large numbers of students has resulted in emphasis upon the kind of knowledge which can be tested in this way, so that the meticulous cataloging of facts, the detailed descriptions of experiments, and the formulations of definitions in terms of stereotyped phrases, have tended frequently to subordinate the meanings of things to the memorization of statements regarding them. It is not easy to test in an examination the kind of meditative power which goes with real understanding, but it is very easy to test the power of memorization of facts and phrases.

A student may study physics, for example, in school and college for a period of perhaps four years, and it is pertinent to ask the question as to how far at the end of that time the subject really has meaning to him. At the end of the individual courses, he is doubtless able to answer the questions set in such a manner as to secure good marks and pass the examinations with high grades. However, after a little time one is apt to find that what he has acquired passes rapidly from him, so that, after a few years, even in the capacity of an educated person—it may be a professor of literature, or the dean of a college, or even the president of a university—the former student of our subject finds himself unable to talk about some of the really simplest and most fundamental phenomena of physics with the degree of sophistication with which literature would be discussed by a group of elderly ladies at a tea party.

In other fields of cultural information such as literature or politics, one finds the former student able to discuss and argue principles of interest with his fellows of similar training with a degree of sophistication bordering, at any rate, upon that of creative thought. Now, I do not mean to say that the person who has had only an elementary grounding in literature or politics will necessarily talk logically and in a manner beyond criticism. The point is, however, that in these fields he will have *some* principles, conventions, likes and dislikes, and I care not whether they are right or wrong, so long as they are reasonably definite. The trouble is that in a subject

like physics the former student at this stage is apt to have no views which come from himself, right or wrong, and is unable to do more than repeat the patter which he has learned. His knowledge of what he says is liable to be limited to the knowledge of which of the words he uses are nouns and which are verbs. This knowledge enables him to string these words into sentences which are grammatically correct but which do not necessarily have any meaning. They provide him who wishes to inflate his ego with the possibility of uttering phrases of apparently profound implication, hopeful in the thought that that which he says to another is more intelligible to that other than it is to him who utters it.

There are three kinds of people who need science, those who need it as a tool of research for the advancement of the boundaries of knowledge, those who need it in the capacity of technicians for the purpose of carrying out definitely prescribed routines and accomplishing well-defined purposes. Finally, we have those in whom we are now particularly interested, who require the subject for its cultural value.

The first of the foregoing categories we may dismiss with the brief remark that however they start to learn the subject, they will finally settle down to a stage of sophistication in thought which is determined by their abilities and opportunities. For the second group, the facts are all-important. In the limiting case, this group is represented by the inventor type of mind, whose knowledge of facts and processes is frequently collosal and who, unimpeded by too strong a conscience demanding a reason for what is done, tries everything in the hope of ultimate success. I would not condemn this process completely when measured in the light of its purpose, for he who seeks to understand everything that happens does discard to a large extent the potentialities inherent in the mere chance that something valuable may result from innumerable trials of half-thought-out processes, particularly when guided by "hunches" which are probably the representatives of conscious or sub-conscious knowledge of other facts and processes related in some way to the immediate objects of interest. To this second category facts are more important than fundamental ideas. Ideas concerned with the empirical correlation of facts are of interest to this group, but ideas concerned with the fundamental relations of things fall largely outside of their category. On the other hand, for the third group, the ideas are more important than the facts and for them the facts themselves perform their greatest function as material for the exercise of the ideas. In astronomy, for example, one may get a superficial exhilaration by contemplating such facts as the masses of the stars, the great distances between them, and their enormous temperatures, but the mind does not find anything on which to exercise itself with permanent satisfaction until it concerns itself with the relationships between such things, or, to use the common but rather debatable expression, until it "understands" them. The process of understanding is a rather subtle one. One may listen for many months to the exposition of reasons for this and for that, arriving at a condition in which he can reproduce the reasons and yet feels a lack of satisfaction in them. There is nothing that he can dispute, but there is nothing which thrills him. Then, it may be suddenly, on some occasion, perhaps in contemplation of some other problem, a flash occurs in which the real significance and power of some of the "reasons" becomes apparent. At that instant real understanding is born; and in my judgment no understanding ever means anything until it has passed through this stage. Everyone who finally understands has to go through processes of mind similar to those gone through by the discoverer of the theorems or principles involved. The difference between the student and the discoverer in this matter is that the latter has no external stimulus of an ani-

mate nature to accelerate the growth of the new thought in his mind, whereas the student has the services of the teacher for the purposes of such stimulation. However, I believe that in the literal sense there is no teaching, there is only *inspiration to learn, or understand.* Knowledge comes from within, out, rather than from without, in, and the true teacher is a kind of Fifth Columnist working in the mind of the student to break down his resistance to a discovery of the truth and slay those various influences which are continually pulling him this way and that in the attempt to sway his line of thought from the fruitful path.

W. F. G. SWANN, *Director*
Bartol Research Foundation of
The Franklin Institute
Swarthmore, Pennsylvania.

V

It was a great advance when human thought achieved the viewpoint that the universe in which we live is an orderly one, not a whimsical chaos. Nature is dependable. Discover the order of her operation, the sequence of cause and effect, here and now, and you may depend upon it that it is everywhere the same, yesterday, today and forever. Her laws are uniform and immutable.

This concept of the invariable orderliness of nature, a universe that is lawful, is one of the most fundamental tenets of science. To discover the laws that state the relation of cause and effect, the fixed sequence of phenomena, and to apply these laws in the solution of problematic situations that confront man, is the chief objective of science.

We sometimes speak, in our pride, of man's conquest of nature. Such advances as man has made are, on the contrary, due to his understanding of and humble compliance with the rules of the game ingrained in the universe.

Science may well caution democracy that government of the people, by the people, for the people is possible only as the people through their representatives are willing and anxious to see and think through their problems by discovering social and economic relations of cause and effect—and conforming to them. The moral values of centuries of experience and experiment cannot be ignored.

To have respect for the laws of the universe, to live in accord with them, is the part of wisdom for one who finds himself, whether he will or no, a resident of the universe. To obey the laws of health, for instance, is to live long, lustily, free from pestering pain, with energy to accomplish what seems worth while. So science contributes to the welfare and sanity of democracy as it teaches personal and community hygiene. It must always be recognized that there are human leeches ready to sap the people's health for filthy gain by tempting youth to unhealthy practices.

Much of the rapid progress in the discovery and application of those laws that operate in the physical world has been due to the scientist's skill in thinking. Not that he is particularly gifted along this line but that it was comparatively easy for him experimentally to check his conclusions. He was forcibly made aware of the errors in his thought processes and driven to correct such by repeated experiences. So he has come to realize the essential elements in science thinking, the safeguards that must be observed to avoid the many possible pitfalls. Science has been dealing with materials that made it fairly easy objectively and promptly to check the results of scientific thinking. It has been possible to follow in detail the mental processes of the scientists both in the discovery of laws and in the application of such laws to the solution of practical problems. So the science teacher has the opportunity to teach not only the subject matter

of science but the method of science. That requires ingenuity. The memoriter learning of assignments in textbooks is as far from the scientific method as are the poles one from another. Science as it has been taught in the common schools has rarely imparted skill in scientific thinking.

In no field is the need of clear thinking more apparent than in politics. To discover the facts in the case, to evaluate them, to use them is the basis for impersonal, unbiased judgment, to reason upon them to conclusions that are criticaly examined and experimentally verified is the rare method of the statesman. The politician is too often a propagandist. But government of the people, by the people, for the people, is safe only when they can think clearly or at least recognize clear thinking. Democracy must be able to detect the fallacies of propaganda. Science can help to train youth.

The third element of democracy, government for the people, is the most difficult to achieve. Government may be democratic in form and yet serve the greed of the few. Certainly many scientists have exhibited rare devotion to the interests of the masses. Their discoveries have been freely devoted to the welfare of their fellows, even at the cost of the life of the discoverer. But their devotion was due not to the fact that they were scientists, but rather to their being Christian gentlemen, or at least to their having imbibed the idealism of a Christian community. One may conceive however that the statement that the greatest satisfaction in life comes from devotion to the welfare of one's fellowmen is a law of the universe, discovered by observation, confirmed by experience and repeated experiment. It is not a law of science, taking the term in its broader meaning. Perhaps after all the prophet and the seer were more or less scientists or at least brothers of the scientist, and the scientist is more of a prophet and seer than he thinks.

Elliot R. Downing
Associate Professor, Emeritus
The Teaching of Science
The University of Chicago.

VI

Possibly the greatest contribution that education in science can make to the democratic way of life at the present time is to alter some of our educational methods so that untold thousands of students annually admitted by the educational institutions of this country can secure proper training in science before being released for their life work.

Relatively few students, either at preparatory school or college levels, have a primary interest in any phase of science, or plan to continue in a scientific field for their life work. In general, the "non-scientific" students elect few courses in science, usually just the minimum that will satisfy the curriculum requirements, and far, far too many graduate with a permanent dislike for science, or at best have a neutral attitude that does not offer any encouragement or appreciation of the world of science for the years ahead. As a result, this so-called "Age of Science" is anything but that in this country. The true situation was ably stated by Dr. A. J. Carlson in his Sigma Xi address at Philadelphia last December:

"It is true," Dr. Carlson said, "that science has, during the last hundred years, increased enormously our understanding of the nature of the world and the nature of man, and with that greater understanding has come greater control of the forces that act in man and in his environment. But fundamental discoveries in science are the achievement of but a few people. The practical inventions based on these discoveries are also the work of a few men, speaking relatively. And the physical and chemical inventions are mostly gadgets that merely modify our tempo and external mode of living. I contend . . . that the great mass of the people of our age, the rank and file of men and women of our day, even in the most enlightened countries, in their thinking and in their motivation are nearly as untouched by the

spirit of science and as innocent of the understanding of science as was the 'Peking Man' of a million years ago. . . . For science is more than inventions, more than gadgets, however useful and important they be. Science is even more than the discovery of and correlation of new facts, new laws of nature. The greatest thing in science is the scientific method, controlled and rechecked observations and experiments, objectively recorded with absolute honesty and without fear or favor. Science in this sense has as yet scarcely touched the common man, or his leaders." [1]

Accordingly some of the basic problems of science education in a democracy are: how to give an adequate training to students who have no primary interest in scientific disciplines; how to get them sufficiently interested by the content of the few courses in science they will take, so that they will have some appreciation of the basic contributions that science has made and is still making to modern civilization; how to give them the proper information, so they will realize the primary importance of scientific research and, therefore, have a sympathetic attitude toward science, the scientist, and the scientific method. Possibly it may be helpful to mention one or two hurdles that will have to be cleared before the present condition can be greatly changed.

Education in science is hampered by the inability of scientists and others concerned with curriculum-building to agree on a consistent program for training in science that can be held up as a standard throughout the various institutions. Educators generally are favorably disposed toward having their students exposed to some sort of science training. But at this point unity disappears; and wide variation is found as to how much and what kind of training in science is desirable. Some say that a purely descriptive, non-laboratory course in general science during the preparatory school days constitutes ample training in science for a life-time of non-scientific endeavor. At the opposite extreme those may be found who argue for rigorous laboratory courses in biology, chemistry, and physics during the preparatory school days, to be followed in college by at least two science courses with laboratory. Between these two extremes various other divergent proposals will be found. Perhaps the variation is primarily due to the experiences of a particular educator in science in earlier years; the memory of a poorly taught, uninteresting course may still be determining the reactions toward the value of science in general. Whatever the cause, it is evident that real progress in science education will be retarded until there is unanimity of opinion among those responsible for establishing curricula.

Education in science is hampered by the inability of science teachers to make their subject pertinent and important to the students. All too often students remember chemistry as an association of disagreeable odors, broken glassware, and detailed notebook data; physics as a dull assembly of formulae, measurements, and mechanics (mostly, *inertia*); biology as a seemingly endless procession of unrelated microscopic minutiae, difficult to study and particularly so to draw. Can it be that the unsatisfactory relations between "non-scientific" students and science courses are due primarily to the fact that many science teachers are primarily concerned with drilling the students in relatively unimportant details of a particular field rather than in the basic principles, and who present their subject as if every student were expected to become a specialist? Or possibly the opposite condition may be true, namely, the instructor is teaching a subject in science for which he has had no adequate training and, therefore, no ability to choose the important materials, and no real enthusiasm in their presentation. Whatever the cause, progress will be retarded until the sciences are taught by those who are thoroughly trained and, furthermore, are aware of the real aims of a particular course.

GEORGE A. BAITSELL
Yale University.

[1] "Science versus Life," *Sigma Xi Quarterly*, vol. 28, 1940.

VII

Alert science teachers of today are keenly interested in the "here and now."

Not so long ago teachers of the sciences and of the classics could hardly be distinguished. Words, outlines, definitions, were their chief materials of instruction. A sort of scientific syntax was the meat on which science students chewed.

An awareness of current happenings marks the modern science teacher. Conservation, the consumer, community economics, and similar broad fields of science socially applied challenge his attention. The news of today—he discovers—was never so full of important scientific stories.

No matter what sciences—general or special—are his fields of instruction, the science teacher of today feels responsible for presenting two aspects of the "here and now": (1) the new developments; (2) the new social significance.

Aviation provides an illustration of these aspects. The industry is founded upon physics and chemistry for its manufacture, to which is added meteorology for operation. But the "classic" principles of these sciences are not adequate information; keeping up with new models, safety devices, records of performance, is an exciting task for a teacher and his students. Of even more significance, however, is the developing air-mindedness of the nation. Young men in science classes plan careers as pilots; girls dream of service as airline stewardesses—if they do not grow too much. The mails, express, business travel, is becoming geared to airplane speeds. (All this in times of peace; war intensifies the significance of many applied sciences.)

New trends in scientific vocations are quite apparent to all uncloistered science teachers—and earning a living is definitely a matter of the "here and now," and the near future. For example, the United States Government has made unprecedented calls for young scientists. Civil Service examinations, announced for the first time in 1939, were offered to college graduates who might qualify as Junior Professional Assistants [1] at $2,000 a year in nearly a score of scientific activities. Undergraduates were examined for posts as Student Aids [2] at $1,440 a year in a comparable number of activities.

These scientific services which our Government now needs are not the outcomes of the traditionel science courses in the liberal arts colleges from which most of the Nation's graduates come. "Uncle Sam" calls for young men trained out of doors, strong of feet and keen of eye, who know the practical science of the skies above, the earth beneath, and the trees between earth and sky.

[1] The examinations for Junior Professional Assistant were taken in 1939 by 38,976 persons, of whom 9,431 passed. In 1940 those examined numbered 44,160, of whom 11,268 passed. It is obvious that the training of a majority of these college graduates was not adequate for the services desired.

The list of "options" of the 1941 examinations for Junior Professional Assistants includes these: (a) Administrative Technician; (b) Agronomist; (c) Animal Nutritionist; (d) Biologist—Wildlife; (e) Business Analyst; (f) Chemist; (g) Economist; (h) Engineer; (i) Forester; (j) Geologist; (k) Home Economist; (l) Horticulturist; (m) Legal Assistant; (n) Meteorologist; (o) Physicist; (p) Range Conservationist; (q) Soil Scientist; (r) Writer and Editor; (s) Zoologist—Parasitology.

From the eligible list of the 1939–40 examinations there were *many* appointments in the following classifications: Administrative Technician; Agronomist; Engineer; Forester; Geologist; Legal Assistant; Physicist; Range Examiner; Soil Scientist. There were a *limited number* of appointments in these classifications: Chemist; Economist; Meteorologist. There were *very few* appointments in these classes: Biologist; Home Economist; Horticulturist. (Information from the U. S. Civil Service Commission.)

[2] The appointments as Student Aid offered summer work during college years under certain conditions. The "options" of the 1941 examinations are: (a) Agricultural Economist; (b) Agronomist; (c) Animal Husbandman; (d) Biologist—Wildlife; (e) Economist; (f) Engineer; (g) Forester (h) Geologist; (i) Home Economist; (j) Horticulturist; (k) Metallurgist; (l) Plant Pathologist; (m) Political Scientist; (n) Range Manager; (o) Soil Scientist; (p) Statistical Expert.

Aviation supplies another current vocational example—that of a complex industry employing a great variety of scientists.[3] The radio makes similar demands.[4] These are types of young, rapidly developing industries, seeking the services of young, rapidly developed scientific workers.

The older industries (agricultural, chemical, electrical, etc.) have taken on new life during recent years, and offer great opportunities to the more original of the young scientists.

Science instruction must keep pace with these developments of "here and now" if schools are to prepare youth for profitable employment. It is obvious that college training is necessary for most of these services, hence the challenge to the college science teacher to stay abreast of current happenings is direct. The high school offers foundations for the college studies, and some of these foundations need to be remodeled. If the nation is beginning to use as many foresters and soil scientists as physicists and chemists, the high school science curriculum needs adjustment.

The teacher's supreme duty is guidance of youth. By all educational philosophies this is considered more important than the facts he presents. Vocational guidance is an acute factor of this duty at senior high school and college levels.

For effective guidance into scientific activities the science teacher must possess both the knowledge and the spirit of the "here and now." He should study chemurgy as well as chemistry; he should inform himself as to the methods of technocracy as well as of technology.

Principles of science are not discarded in his modern courses, but their applications are brought up to date. History of scientific achievement is not neglected, but he is aware that history is being made faster now than ever. For the inspiration of great lives an inventive Galileo can be matched by an inventive Kettering, a persistent Cyrus W. Field by a persistent Arthur H. Compton; a patient Copernicus by a patient Langmuir.[5]

The teacher is well aided in his efforts to present the science of the hour. Scientific magazines at various experience levels are numerous.[6] Books[7] are written soon after significant developments appear. Films[8] are available of high quality and great variety. All that is needed further is the alertness which characterizes the modern science teacher who accepts the opportunities of the "here and now."

[3] See *A Guide to Aeronautical Occupations*, The Boeing School of Aeronautics, Seattle, Wash. The fifteen major occupations listed are (a) Airline Pilot; (b) Commercial Pilot; (c) Airline Maintenance Engineer; (d) Airline Meteorologist; (e) Airline Dispatcher; (f) Aeronautical Engineer; (g) Airline Radio Operator; (h) Airline Radio Maintenance Engineer; (i) Airline Service Mechanic; (j) Airline Overhaul Base Mechanic; (k) Instrument Mechanic; (l) Factory Mechanic; (m) Administrative Operator; (n) Airline Sales; (o) Aviation Instructor.

[4] Is the science teacher familiar with *The School of the Air*, an international project of the Columbia Broadcasting System?

[5] If it were not probable that these matters will be discussed by other contributors to this symposium, an extension of the following topics would be presented:

(a) Motivation is a strong factor in the study of the science of "here and now." The student is eager to be a part of the yet greater science that is to come.

(b) Culture need not be neglected in training for a practical world. Never before have scientists collaborated so effectively to aid the artist, the musician, the playwright.

[6] The adult level of experience is served by such practical magazines as *Aero Digest, American Forests, Food Industries, Motor, Natural History, Science Digest, Science Leaflet, Science News Letter, Scientific American.* For a full list see the Trade and Class Section of *Ayer's Directory of Newspapers and Periodicals.*

On the high school level are *Popular Mechanics, Popular Science Monthly, Science Observer* and other excellent monthlies for club and library use. The weekly, *Current Science,* is for classroom use.

[7] Consult the author's annual booklist, "The High School Science Library."

[8] Practical chapters on visual aids are found in *Modern Methods and Materials for Teaching Science* by Heiss, Obourn, and Hoffman (The Macmillan Co., 1940).

HANOR A. WEBB
Department of Science Education
George Peabody College for Teachers
Editor of Current Science.

NEEDED RESEARCH IN SCIENCE EDUCATION *

A. N. ZECHIEL

Commission on the Relation of School and College, Ohio State University

The only excuse that the speaker has for presenting a paper on the topic of "Needed Research in Science Teaching" comes from the opportunities of the past few years to survey the needs, doubts, problems, and working conditions of the "man on the front line," the science teacher.

The topic is much too broad to be treated in a single paper so certain limits must be laid down at the outset. The discussion which follows will concern the Secondary School (7–12) only although there may well be many problems discussed or raised that pertain to the Elementary and Junior College fields. This limitation to the Secondary field is necessary if the problems raised are to have the assurance of validity for in that field the speaker has worked hard and diligently, if not always, effectively, with science teachers on a country wide scale. No claim is made that this discussion will be authoritative or that the problems raised will represent a complete and exhaustive listing of needed research. An attempt will be made to summarize the problems facing some two hundred or more science teachers with whom the speaker has worked for a period of four years in schools scattered from Boston to Los Angeles, representing private schools, university experimental schools, single public schools, and four large school systems.

It is assumed that the purpose of research in science teaching is to improve the quality of instruction in the science fields—a trite and meaningless statement. The questions might well be raised as to what constitutes "improvement"? In what direction should improvement be sought? What values should be sought for?

The past thirty years has been a great shift in the nature of the high school population. The main problem of the secondary school today is not college preparation as it was in 1910. The problem today is chiefly in the area becoming known as "general education." This is not news but common knowledge. It does, however, raise serious problems. These problems fall quite generally into one or more of four categories: (1) objectives, (2) subject matter, (3) instructional techniques, and (4) evaluation —the four problems areas of any educational program.

The nature of the problem in the area of objectives is largely philosophical, and an excellent foundation is already laid. *The Thirty-First Yearbook, Science in General Education,* and the report of the Objectives Committee of this organization published in *Science Education,* October, 1938, are all concerned with this problem of general education and are in pretty general agreement.

Requirements for graduation from high school and for entrance into liberal arts courses in college almost universally contain the item, "One laboratory science, which may be chemistry, physics, or biology." Thus we see that any one of three separate and distinct bodies of subject matter may be submitted for satisfaction of a single requirement. This leads us to assume, then, that it is not the content of these courses that is considered of primary importance but that there must be some factors or outcomes common to all.

If this assumption is sound, then we must look to the area of personal development for our most important objectives of science education. What are the skills, abilities, habits, attitudes, appreciations and social understandings that are to be accepted as important and which we shall

* Presented at the meeting of N. A. R. S. T., February, 1941.

use as the criteria governing choice of instructional techniques and our program of evaluation? All three of the publications listed previously have recognized these areas of personal attributes as of great importance but the startling fact is easily discovered that they have not influenced science instruction to an appreciable degree. Here, then, is a unique research problem, unique in that it has never received much attention. How can the products of philosophical research be put to use? How can they become effective on the front line?

It is not sufficient to publish such findings. From my observations in schools that are certainly not *below* the average secondary school, less than 10% of the science teachers had ever read any of the references quoted or any similar philosophical study. Similarly, convention reports, papers, or discussions effect little change in school practice or textbook formulation. Our science education magazines reach a negligible majority. To state our problem another way, "How can the secondary school science teacher be trained so that he will be an intelligent consumer of the research findings of specialists in the research field?"

In the area of content some new problems are facing the research worker. These problems are new because new approaches to the validation of subject matter to be included in the curriculum are being used. The approach to curriculum building dominant during the past fifty years or more has been the "subject field" analysis. A field of knowledge such as chemistry, physics, physiology, geology, botany, or zoology, has been carefully analyzed, a logical organization achieved and the course taught according to the sequence of this logical organization. The failure of such organizations as separate courses to reach all students led to experimentation with fused courses in "general science" and "biology" in order that students might have experience in more than one or two of the science fields. The content of these fused courses, however, was determined again on an analysis basis with the application of some additional criterion such as "understanding one's environment."

Two new approaches are now in common use in arriving at decisions on the subject matter to be used in the secondary schools. The first of these might be called the "social demands" approach, an outgrowth of the job analysis approach sponsored by Charters and others several years ago. Caswell is a leading exponent of this approach and his influence is to be found in the state programs of Kansas, Mississippi, Virginia, and many city-wide curriculum reorganizations. The "areas of human experience" or "problems of living" are analyzed as to their implications for content. For example, the Mississippi program uses such categories as "Protecting Life and Health," "Getting a Living," "Making a Home," "Cooperating in Social and Civic Affairs," "Engaging in Recreation," and "Improving Material Conditions." These categories are then analyzed as to the problems involved and units of work designed to study such problems. Courses organized on this basis become the study of persistent and recurring problems of our society.

A second procedure coming into wide use might well be called the "adolescent needs" approach to curriculum building. This approach differs from the social demands approach in that the primary emphasis is on the concerns, tensions, and problems of the adolescent rather than the demands, and problems of contemporary society. The two approaches have much in common as many of the concerns of the individual grow out of his social environment and many of the societal concerns are in terms of the common problems of the individuals comprising that society.

Teachers concerned with either one of these two new approaches, or using the combination of the two approaches, to curriculum reorganization need the help of skilled research workers. They are asking

questions such as these: (1) What are the persistent and recurring problems of society and of the individual that can be dealt with by science teachers with their laboratory resources more adequately than by any other area of the school? (2) What resource materials are available for considering these problems? (3) What shall be the course organization? (4) How can I also care for the "needs" of the potential specialist or student who has a special interest in a field?

Some new or relatively new course organizations are making their appearance in the secondary school curriculum in an attempt to meet the requirements of the social demands and adolescent needs approaches to curriculum building. Most of these courses cut across the subject-matter boundaries of the traditional high school curriculum. These "fused" courses are of two types (1) Broad Fields Courses and (2) Core Courses.

The broad fields courses cut across subject fields within a single area. General science and biology are examples of this type although they are not new. Advanced physical science courses such as in Los Angeles, Lincoln, Chicago University School, Des Moines, and many others are receiving experimental trial at present. Some of these courses (University of Chicago) achieve organization by subject analysis with the additional criterion of understanding one's environment. Others, Los Angeles, Des Moines, use a combination of social demands and adolescent needs approach to decisions relative to both scope and sequence. Here is a very fertile field for research. Which of these two approaches best meets the demands of a general education program? Is either or both superior or inferior to the special subjects approach for a program of general education?

Denver, Tulsa, Evanston, Los Angeles, and many schools in the South are organizing courses called "core" courses in which the lines between fields disappear. Subject matter in such courses draw from many fields, social studies, literature, science, mathematics, home economics, sociology, economics, and others. The courses are as a rule concerned with problems of the adolescent and of society. Sequence within such courses is achieved by the use of some "overarching" theme (Home and Family Life), or by class decision to study certain problems. To a group such as this, familiar with *Science in General Education*, it is not necessary to point out the possible contribution of science to courses organized to consider adolescent needs by direct methods. How to most effectively make this contribution is, however, an acute problem. How can the science teacher function most effectively? How can the experimental method and resources of the laboratory be efficiently used?

Another problem in organization of instructional materials confronts the science teacher in schools working on a general education program along the lines outlined above. All schools have a few pupils preparing definitely for vocations or professions in which thorough mastery of one or more science fields is essential. Shall the needs and interests of such students be neglected? Most of the science teachers in these schools answer in the negative. Assuming that the special-subject organizations of physics, chemistry, etc., are not the most satisfactory for general education but that they are the most effective organization for the pre-vocational or special interest student, what can be done? Tower Hill School advances a fruitful hypothesis. Their solution is a program of general education by means of broad fields and core courses through Grade 11. During the 12th year the special interest and pre-vocational pupils have the opportunity to take special courses of semester length. The pre-engineering student takes one-half year each of chemistry and physics; the pre-medical student chemistry and advanced biology. Unfortunately the school enrollment is too small to furnish reliable

data as to the success of this organization for the specialist group. Investigation of this organization on a large scale should offer valuable data. If the answer should be in the affirmative, science teachers would feel much freer to experiment in the general education field. If the answer should be in the negative, data should be available indicating other promising hypotheses.

Research is needed in the third category of problems, namely, instructional practices or techniques. Many teachers are challenging the use of the laboratory-manual technique for individual laboratory work. They maintain that following the instructions of a laboratory manual does not provide training in scientific method. Is their assumption justified or not? If true, how can the scientific method be taught successfully? There are many other problems in this area of instructional practice. As an observer in hundreds of classrooms, the items reported as important in the committee report of this organization (*Science Education,* October, 1938) are ignored to an alarming degree. Science is not regarded as "A method of thought" or "A living experience." Science teaching is not greatly concerned with "The social implications of the subject matter." Science teaching is not concerned with "attitudes of mind," "methods of thinking," "power of interpretation," "ability to evaluate data," "ability to take an objective attitude toward facts." In fact, go through the statements of the committee printed in black type, the items considered by a competent jury as of dominant importance (many of you here participated, so it must be competent) and you will have a pretty accurate picture of what is not being done, or of what is not considered important. This does not mean that teachers are of low ability, or non-professional, or disagree in principle with the findings of the jury. Study the items carefully and see the large number of them concerned with skills, abilities, habits, attitudes, and appreciations. Then take a mental survey of the research literature and see the meager amount of information available in this area. The committee report opens up dozens of research problems involving classroom practices, for skills, abilities, habits and attitudes result from action, not memorization, and are therefore functions of classroom techniques not content.

This leads us directly into the heart of the problems of evaluation. Truly "scientific" research is dependent directly upon effective instruments of measurement. The ease with which fairly reliable instruments can be designed to measure fact mastery has been responsible for a misplaced emphasis in science teaching. Our committee report, if summarized in one sentence, maintains that subject matter is means to an end and not an end in itself. Evaluation instruments are needed for the ends we have agreed are important. Tyler and his staff have made a significant start but it is only a start. They have opened up new techniques that are valuable and useful to the research workers in the fields of content and techniques. They need extension into many other avenues and to be simplified so that the data are more readily interpreted by classroom teachers.

The literature of research in the teaching of science is filled with reports of problems in the field of classroom teaching techniques in which the only measuring instruments used have been fact mastery. In the light of the objectives sponsored by leaders in the field these research studies have little meaning. We need "working tools" for our research and the most needed tools are technique for appraising the degree to which outcomes in the areas of skills, abilities, habits, and attitudes are being or can be realized.

Two difficulties have prevented wide research in the evaluation of such "personal characteristics." (1) The time factor: most research is of short duration because all too frequently the real purpose of the

research is to acquire a "degree." (2) The difficulty of collecting valid observational data: we are not interested in the exercise of these skills, abilities, habits, and attitudes in the science classroom alone. We wish to see these behaviors functioning in the daily lives of students, in the total school life, in the home, in the community, now and throughout life.

Evaluation of these so-called intangible objectives is certainly a wide-open field for a long-time research program.

The classroom science teacher does not profit very much from research studies of the philosophical or questionnaire type so frequently found reported in our literature. The problems which the practicing teacher faces are more than a clear understanding of the purposes of his work or the nature of his educational philosophy. His problems begin when these understandings are achieved. He wants to know "how" to achieve purposes, how to implement an accepted philosophy. This suggests that the areas of research most needed must be in the nature of field studies with evaluation of the research in terms of the "real" purposes of science education not fact mastery of science knowledge. Have we applied the method of science in our own research too rigorously by insisting that our research studies have statistical respectability. Is it not possible to be an honest investigator and place greater confidence on subjective judgment, anecdotal records, and student reaction to a given experience?

A few of the problems facing science teachers have been briefly outlined. In some cases the nature of these problems has been indicated. I cannot close a discussion of the topic without reference again to the one big problem facing research workers in the field of science education. It is a problem that is common to all research in the whole field of education. The problem is not one concerned with objectives, content, method or evaluation, but with the prospective consumer of research, the classroom teacher. How can we make the findings of research effective in improving the educational offerings to the youth in our secondary schools?

A doctor may diagnose an ailment of his patient with great accuracy, and may show a fine degree of professional competency in prescribing a treatment, and still fail. All this effort and intelligence is wasted if the patient refuses to follow the treatment or never learns what the treatment is to be. The analogy is an accurate one in describing the relationship between the classroom teacher and the research worker.

Two fruitful hypotheses relative to a solution of this problem need exploration and careful consideration.

(1) *Improving the textbooks available to the science teacher.* The only science literature read by a large majority of secondary school science teachers consists of the textbooks they use. Teachers have a great deal of confidence in textbook authors, much greater than is deserved and I am sure much greater confidence than the authors themselves wish them to have. Would it be profitable to make a philosophical study as to the "nature of the ideal textbook"? By making such information available to authors could we influence textbook construction and in this way reach the classroom teacher and improve his work?

(2) *Increasing the participation of classroom teachers in carrying on research problems.* This hypothesis seems very fruitful for two reasons, (1) an increase in the data available on problems of classroom concern and (2) participation in research is a potent factor in teacher growth and development. The advantages which might come from an increased body of data on classroom problems seems so obvious that it needs no discussion. If the conclusion of the speaker is an accurate one, that the most needed research is in the area of "how" to teach rather than "what" and how much, we must look to the classroom teacher for help. Greater emphasis is

needed on classroom research and less on philosophical arm chair and survey by questionnaire techniques.

The most significant conclusion coming from the study of the experimental schools participating in the work of the Commission on the Relation of School and College concerns teacher growth and development. Participation in experimental work has been a dominant factor in increasing teacher effectiveness. In an experimental project a teacher is forced to clarify his philosophy of education, to clearly state and completely understand his objectives, and to challenge his daily procedure in the light of his philosophy and objectives. The results in terms of increased effectiveness in case after case would make suitable material for one of Ripley's "Believe It Or Not" cartoons.

While these direct benefits accruing from the participation of teachers have been very great, an indirect benefit is, for our concern, still more significant. The data made available by teachers engaged in research may be of little or no significance on a large scale, yet huge dividends are realized for there is no better method of increasing one's effectiveness as a "consumer" of research findings than to be an active participant in a research problem.

Every school of education, every research worker on educational problems, should be the center of a long range experimental program using the services of teachers in the field. We need to pay more attention to in-service teacher training and by far the most effective in-service training I have seen comes from the participation of teachers in a research program.

AN EVALUATION OF BROADCASTS AND RECORDINGS FOR THE SCIENCE CLASSROOM

J. ROBERT MILES

Research Associate, Evaluation of School Broadcasts, Bureau of Educational Research
Ohio State University

Ever since nation-wide broadcasting began educators have been writing and talking of the potentialities of radio as an educational device. They have seen it as a means of raising the standards and extending the appreciations of all men for the good things of literature, music, art or science. They have envisioned vocational guidance and avocational hobbies being developed through its use. Some educators have sought to maintain radio stations devoted to purely educational service and have fought bitterly the steady encroachment of commercial enterprise as it has forced more and more educators off the air. The hopes of many of these men for a great revival of public education through radio have resulted only in disillusionment, for the public has seldom received well the broadcasting efforts of the academic educator and educationally operated radio stations have dwindled in number throughout the last decade. The American public and the American broadcaster have come to see radio as an extraordinary means of implementing the "pursuit of happiness" for the common man, a convenient and economic way of being entertained and informed of current happenings rather than of being academically educated.

All this means that the radio industry has been developed by giving to audiences what they wanted or found to their liking rather than what they needed as the educator might have prescribed it. While

educators have only recently sought to utilize in their schools the "felt needs" of the average boy or girl, the practical men of radio long ago discovered that a listening audience is not maintained by programs based on the assumed value of knowledge for its own sake. That rigid test of success—gaining and holding a voluntary audience—has been faced by radio as education has never faced it. The present loyalty and dependence of a huge part of the American public on their daily radio diet is a revealing development for educators who would make education more influential and dynamic in the social scene. Broadcasting in the public "interest, convenience and necessity"[1] has become in two decades a permanent social institution, a billion dollar a year industry and a tremendous educational force in American life.

People generally have accepted radio without considering the significance of the role it has assumed. Our younger generation especially is unaware of the influence of radio in their lives. Many of those now in our schools have literally grown up with radio from Amos and Andy to Jack Armstrong, and therefore notice its occasional absence much more than they do its customary presence. Surveys have shown that almost all American homes possess one or more radios and that young people listen an average of two or three hours every day. Some of this listening involves intense attention to the radio alone while at other times listening is a "marginal" activity accompanying the doing of other tasks. People listen while they eat and while they play and while they read or study. Some young people listen for amusement, others for news, and others for excitement and escape. But what do they learn? What attitudes do they develop through their listening? In what activities do they become interested through radio? Is radio really the temporary, fleeting influence in our lives which most people accept it to be? Or has it become an important factor in the development of the personalities of today's youth? Is the radio program perhaps an avenue of youthful thoughts, habits and general behavior which presents both an opportunity and a challenge to the educator?

I present these questions in order to emphasize the fact that our present discussion of the values of broadcasts and recordings for the classroom is closely interrelated with the values of broadcasts in the home and elsewhere. The necessity of maintaining this perspective while thinking about radio in education is illustrated by our failure to do likewise in our use of textbooks and visual aids. For the lack of discrimination and the undesirable habits which many of our present school graduates reveal in their movie-going and in their reading today suggests the need for school experiences to be more closely related to out-of-school experiences. It is my belief that radio can best serve the educator who wishes to make school life more continuous with and hence more affective in life out of school and after graduation.

In the time of a single discussion period such as this it is necessary that our survey of research on radio education be limited to the area of science teaching and to the presentation of the problems and opportunities faced by science teachers who wish to use broadcasts or recordings in the classroom.

Radio programs concerned with information about various fields of science have been on the air for many years. They have referred to health, home making, and nature study as well as to specific topics on the physical or biological sciences. Occasional programs or series have been devoted to the direct teaching of a general science course as in Chicago, Cleveland, or Rochester, but by far the majority of radio programs involving scientific knowledge have sought to illustrate applied science in action.

[1] This phrase refers to the demands made on broadcasters in the Communications Act of 1934.

Educational research as to the effectiveness of these broadcasts has been meager and inconclusive but the few studies completed have been almost uniformly encouraging. The few controlled studies that have been made have dealt with elementary or general science and have indicated that radio can be successfully employed to increase the amount of student information, to develop desirable attitudes, and to extend science activities and interests at that maturity level.

It is significant that a recent survey of radio research literature conducted by our Ohio State project has revealed no studies of the use of radio programs in the teaching of science in the secondary school. Out of some four hundred articles, theses or books thus far collected which relate to the educational significance of radio, not more than ten have pertained to the teaching of science either in or out of school. Most of these ten have made the acquisition of information the criterion of value, although Carpenter's study of his Rochester programs and Casey's study of the American School of the Air at the University of Texas were concerned also with student attitudes and interests.

The feeling of the research staff of the Evaluation of School Broadcasts project is that information may be imparted successfully by any teaching technique properly used and that radio cannot be justifiably introduced into the classroom on that basis alone. Of course, circumstances may be such that knowledge of science cannot be otherwise presented, as in some rural schools were neither trained teachers nor essential equipment is available. But generally speaking, the contributions of a radio program are those of enriching the curriculum through convincing presentations of applied science in everyday living—in the home, in industry, in agriculture and in nature study. Here radio may broaden and intensify student interest in the social significance of science of the past and present by providing vicarious experiences not otherwise obtainable in the classroom.

Our several studies of the values of radio programs in science teaching have been directed toward these latter objectives. But here again, elementary science was found to be the only level at which radio programs were being consistently used to supplement teaching. An illustration of the effectiveness of radio in science teaching is provided by two controlled studies which our staff has conducted with the program of the Chicago Radio Council "Your Science Story Teller." These studies have indicated that pupils enjoy such programs and gain considerable information from them. But more important, these studies suggest that desirable attitudes, as in various aspects of conservation of natural resources, can be effectively introduced by radio programs. Student interest was also shown to have been significantly affected by these "Story Teller" programs, the experimental classes which heard the programs having been much more active than matched control classes in following up their interests by reading, writing, visiting parks, museums or factories, and performing simple experiments at home and in school.

Granting, if you will, that available evidence suggests the effectiveness with which radio could be more widely used to supplement science teaching, other difficult questions arise. Administrative and curricular problems involved in getting appropriate programs "on the air" from the right station and at the right time are seemingly insurmountable. Of course, a local school system which can produce its own radio programs can find solutions to the problems, but what of the vast majority of smaller communities? Even when state "Schools of the Air" are developed as in Wisconsin and Ohio, it is extremely difficult to provide any considerable portion of the potential listeners with broadcasts suitable in content, maturity level and time of presentation.

Two alternative avenues to the use of auditory teaching aids are available for schools, first, through the use of recordings, that is, phonograph records and radio transcriptions and secondly, through in-school broadcasting over a public address system. Of course, these two approaches may be combined in the playing of records or transcriptions to the rooms of a school over the public address system. Perhaps it should be here noted that phonograph records turn 78 r.p.m. and radio transcriptions 33⅓ r.pm. and that record players or "playbacks" which will operate at both speeds are available for schools.

Several of our ESB studies have used recordings as the experimental factor. One study conducted by Mr. J. W. Wrightstone of our staff has given evidence that recordings are as effective as live programs. In this study made in a junior high school at Bronxville, N. Y., several American School of the Air programs were heard by one group of classes via radio and by another group of matched classes via recordings. Tests of gains in information and shifts in attitudes and interests revealed no significant differences between the two groups. Another interesting study in which recordings were used was conducted in Cicero, Illinois, by Mr. Cuthbert Daniel and Mr. J. Robert Miles. These Cicero elementary students heard recordings that had been selected from NBC and CBS programs (both in- and out-of-school programs) to supplement the accepted course of study of that school system. The results of this study definitely indicated that the classes hearing recordings were much more interested in finding science information than classes not hearing them. The recordings apparently stimulated the experimental classes to a much greater intensity of interest than customary classroom procedures used in the control classes.

Hence there are two reasons for believing that the use of recordings in schools will soon be considerably expanded. One is that the administrative and curricular problems involved in using live broadcasts are largely eliminated and another is that the effectiveness of recordings has been demonstrated to be little different from that of live broadcasts. But there are additional reasons for an extension of the use of recordings. First, teachers can know about the maturity and the content of recordings before they are used and can therefore better select and plan for maximum utilization of the experiences provided. Second, recordings can be re-played at any time and a school library of evaluated auditory experiences can be accumulated. Third, and most important, broadcasters and recording companies are rapidly becoming aware of the potentialities of such a school market and are making many more recordings available. Fourth, recording and playback equipment has been greatly improved in the last few years at the same time that prices of equipment have decreased, that is, two-speed record-players and apparatus for making records have been simplified and made more efficient.

In anticipation of the potential spread of the use of recordings, our Ohio State staff, in cooperation with the Association of School Film Libraries in New York City, last year embarked on a project whereby the educational recordings available for school use [2] might be collected and evaluated. Even excluding music records, the number of discs thus far collected—over a thousand—is amazing and the variety of content covers almost all subjects in the public school curriculum. These programs have come from 25 professional recording agencies, not including the broadcasting companies, and have generally been of excellent quality both mechanically and in terms of production techniques. The present prospect of the release by the National Broadcasting Company of many recordings of its past educational series will make an

[2] This does not include the innumerable music records that have been used in schools for many years.

even greater variety of programs available for school use.

In view of the many hundreds of records and transcriptions which have been accumulated since this evaluation project started last year, it is obvious that a controlled study of the effectiveness of each program or series of programs would have been an impossible undertaking. Furthermore, the basic question as to the possible effectiveness of the use of recordings has been answered in previous experimentation. Our problem was rather that of appraising the potentialities of these many recordings for the supplementation of teaching in various subject areas and maturity levels. A descriptive evaluation of the content, the mechanical characteristics and the probable appeal of these many recordings was therefore the responsibility accepted in this cooperative project. In setting up the procedures whereby appraisals could be rapidly completed, the aid of many teachers in elementary and secondary schools and colleges has been enlisted. Subject-matter experts have checked the authenticity, accuracy and general significance of the content and suggested certain uses for each program. Many public school teachers and their students have used these recordings and have criticized them from the standpoint of their educational value, their clarity and comprehensibility and their appeal to youthful listeners. The latter groups also suggested the units and subject areas in which the recordings might be appropriately used and the maturity level ranges within which they could be clearly understood. Thus far, the appraisal of approximately six hundred records has been completed and partial data has been secured preparatory to writing appraisals of many other programs. Generally, teachers have been enthusiastic about programs which were appropriate for the maturity level of their students and which implemented some of the purposes or values in their educational philosophy. The effectiveness of recordings has been repeatedly shown to depend on well-planned utilization. When wisely used, recordings have been reported to have uniquely illustrated facts, events, personalities, issues; to have stimulated or sustained desirable student interests and attitudes; to have given greater vitality and significance to subject-matter; to have motivated student activities both in and out of school. All of the responsibility for the final summarization of the many appraisals of these recordings has been taken by members of our Ohio State Staff. A catalogue of these appraisals is scheduled for publication during the coming summer.

In reviewing and appraising the many recordings, some which were pertinent to the teaching of science have been found. As in the case of radio broadcasts, the number of recordings pertaining to science is considerably less than that pertaining to other subject-matter fields. It should be noted here that the lack of recordings in the field of science could easily be met. For example, the National Broadcasting Company has several series such as the *World is Yours* or *Ideas That Came True* which could and may soon be released for sale to schools. Likewise the Columbia Broadcasting System's *The Human Adventure* or *Men Against Death* are interesting series that could easily be made available. This is particularly true of the *Men Against Death* programs which the Federal Theater Project produced by adapting the works of Paul de Kruif for the radio. The master recordings of the de Kruif series are even now resting in the vaults of Station WOR and could easily be used to produce pressings. Furthermore, the cost would be comparatively little, inasmuch as the whole expense of the production and cutting of these records was borne by WPA. A recent letter from Miss Emilie Haley of the Association of School Film Libraries asking whether it would be worth while to consider making available to schools the pressings of the de Kruif series can only be answered by such groups as this. Twelve of the de Kruif programs

which were recorded were secured for our evaluation project and have been enthusiastically praised by the many science teachers who have heard them. Likewise, many of the NBC recordings involving scientific content have been appraised and could profitably be used in various science units in the junior or senior high school.

In turning to the possible uses of in-school broadcasting let us consider the responsibilities of science teachers. First of all, our exploration with this device has suggested that both administrators and faculties of school systems are going to look to the science teacher for advice about the purchasing and servicing of such equipment. Certainly, one of the competencies which should be required of the graduates of our teacher-training institutions is that of familiarity with equipment used both in audio and visual aids. For example, a physics teacher in South High School, Columbus, Ohio, Mr. E. S. Stauffer, has been largely responsible for the efficient installation and operation of the public address system in his school. He has, furthermore, secured equipment for making and playing recordings. In this school, the use of recordings has developed to the point where all teachers feel free to ask Mr. Stauffer to transcribe either in- or out-of-school broadcasts which they would like to use in their classes. Hence, an extensive library has been accumulated in this high school, which consists of records purchased from outside agencies as well as recordings made by Mr. Stauffer. His development also of student crews for the operation and servicing of both audio and visual equipment suggests a means by which the science department may both serve the school and give vocational training to its students. Furthermore, his work with the speech and dramatics teachers indicates how essential auditory aids are for this department.

As the above illustration suggests, the use of recordings and public address systems may place much responsibility on the science teacher. In this respect, our experiences with schools have revealed that some school equipment has been unwisely selected. For example, some public address systems have been installed using unshielded cable or poor loud speakers or with no provision for playing records. Where such playback equipment has been purchased, it has often contained single-speed motors which play only phonograph records. Other schools have purchased portable record players which would take only the 12 inch phonograph record. It would seem that science teachers can logically be expected to become better acquainted with such equipment than any other members of a school faculty and, except in those cities which maintain their own purchasing and repair departments, should be able to select the best available equipment.

In the few schools which are using recordings and are producing broadcasts over their public address systems, an integration of student learning has been reported by teachers. The common purposes which exist but are not always recognized by teachers in different subject-areas have been revealed by such use of auditory aids. A social science teacher may have discovered that programs on science, literature, music or drama were an effective approach to the teaching of history or civics. Teachers of speech, dramatics or language may have found that the local science teacher could suggest excellent recordings for their courses or could supervise the use of recording equipment. This recognition of a mutual striving for certain changes in student behavior has been an important outcome in these schools, many of which have developed radio workshops in which many teachers have cooperated. Perhaps auditory aids can implement the generally recognized need for greater integration in student school experiences.

In conclusion, it appears that radio and recordings are as yet largely unused in science teaching even though radio receivers and phonographs are the product of

scientific effort. Nevertheless many teachers and administrators are beginning to explore the use of such auditory aids. Cities such as Los Angeles, Rochester and Chicago are now producing their own school broadcasts and are engaged in building recording libraries. State departments of education are asking how recording-loan libraries can be developed. The pamphlet prepared by the Association of School Film Libraries listing available "Educational Recordings for Classroom Use" has been widely circulated and constant inquiries are coming to our office about the evaluative catalogue of records which is to be released next summer.

Groups such as the National Association for Research in Science Teaching can do much to promote the wise use of such teaching aids. They can insist that future science teachers shall be competent in the use of radio programs and recordings as well as able to advise administrators about the purchase of equipment. They can cooperate with broadcasters and recording companies in developing programs that are appropriate and effective. They can assist in the dissemination of research findings such as those which will be completed by our Ohio State project next year. Recognizing that radio and recordings will probably be even more widely publicized as teaching aids, the advice of well-informed science teachers will be greatly needed in guiding the expansion of the use of these devices; and with a larger view, the efforts of science teachers are likewise needed to enable students to better discriminate in their use of radio out of school.

GOALS IN THE PHYSICAL SCIENCE SURVEY

MORRIS GORAN

Schurz Evening Junior College, Chicago, Illinois

After the studying of conglomeration of material gleaned from the subject matters of physics, chemistry, astronomy, and geology, called "Survey of the Physical Sciences," some students feel confused, "mixed up," bewildered, and may increase their awe for physical science because of incomplete understandings. Others are irked by the superficiality of the course, believing they have attained a mere spadeful from the total capable of being unearthed. The latter, properly inspired and directed, can go on to special studies in order to satisfy their desire for thoroughness. A third group becomes dissatisfied because the myriad facts presented to them are not seemingly correlated; the isolated bits of information are retained as end pieces, to be lost like the outer packages of an overloaded and poorly-fastened merchandise truck as it rolls down the street. A fourth large sector of the students who completed the physical science survey criticise the course because of impracticability. Even the cultural aspects are scored as not applicable, nor exploitable, nor realistic in a bomb-scared world.

Appropriate goals, with proper selection of material to accomplish the ends, can reduce student dissatisfaction to a minimum. The appropriate goals are the only rational and experience-tested ones, from the standpoint of both the cultural and prevocational aspects of the course.

At Schurz Evening Junior College in Chicago, students are expected to develop a good idea of energy and its inter-relationships, the science world-view, and scientific method and attitude. The three concepts form the core around which a year's work

is built. Each is equally important, and equally emphasized.

Because the study involves no laboratory work, scientific method and attitude are described in detail, and illustrated with examples from the mine of material found in the history of science. The meaning of experiment and observation, their characteristics and function, the value of hypothesis and their place in research, the significance and use of mathematics, and the uncovering of cause-effect sequences are pointed out. When the process becomes too philosophical and abstract, contrast, simile, and biographical material are introduced.

To absorb the facts of physical science does not, in general, contribute towards a working understanding of scientific method. Students must therefore receive some practice in employing portions or all of the method. One means is to propose questions which aid hypotheses formation, critical analyses, and marshalling of facts. Determining what would happen if the earth suddenly stopped rotating, or the sun became as small as the moon, engenders creative thought and logical testing of ideas, a process occurring in the early stages of scientific method. Well-chosen demonstrations should illustrate the use of experiment, the importance of measurement, and the search for causal agents.

To illustrate scientific attitude, examples of international cooperation, tolerance, suspension of judgment, objectivity, and criticism are cited in the lives and achievements of famous scientists. No attempt is made to apotheosize; whenever the life of any one scientist has served too often as an example, his human failings are analyzed. There should be no deadening of the critical faculties, whether in discussing scientific attitude, or prejudice and dogmatism.

The science world-view is inculcated through virtue of the study. But it must be shaped and directed, coalesced and molded. From the facts of astronomy, man's place in a vast universe should be evident: The dominant animal on a speck of matter. Too, the contrast in size between the earth and the sun, and other astronomical bodies gives a useful perspective. From physics, chemistry, and geology, the workings of nature on the speck of dirt are shown to be orderly, rational, predictable, and controllable.

The inter-relationships of energy are found in the material of physics and chemistry. With the fundamental building stones of matter, electrons, protons, neutrons, positrons, mesotrons, neutrinos, and deuterons described, their presence in all forms of energy can form a unifying concept. The workings of mechanical, thermal, chemical, electrical, and radiant energy are shown to be similar, and interpreted as manifestations of the primary particle-wavelets.

With an attainment of the goals, students can have little dissatisfaction with or fear of physical science. Their knowledge of the study becomes comparable to a tall, straight tree-trunk which can grow numerous branches incapable of being blown away by the wind, which can serve as a guiding post, an aid to perspective, and an observatory where new horizons can be had.

A METHOD OF DETERMINING THE VALUE OF JUNIOR HIGH SCHOOL SCIENCE COURSES

G. M. RELYEA
University of Utah, Salt Lake City, Utah

In general, may we not say that a Junior High School course of any kind is valuable if it functions in a child's out-of-school activities? The course may provide new information and skills on a previous experience, it may introduce a new interest, it may lead to a decision as to life vocation or avocation, it may do other equally worthwhile things—but if it does any of these, is it not to be rated as a successful course? This is the point-of-view which we took in judging the three-year science program of the Stewart Junior High School of the University of Utah.

The first step in our "Study for the Determining of the Value of our Science Program" was the listing of fifty-seven out-of-school science activities, selecting the items on the basis of our knowledge of our children and their homes, travels, reading, hobbies, etc. As a second step, the list was checked early in the school year by each student, to ascertain his degree of interest in the activity, his past participation in it, and his desire for future participation. (See *Science Education* for Feb. 1940, pages 84–7 for complete list.)

Several months of the school year passed, during which time the usual Science courses were given—Natural Science in the Articulating Unit (Seventh Grade), General Science in the Eighth Grade, and General Biology in the Ninth Grade. Nothing more was said about the List of Activities and so far as possible, the classes were carried on in the usual way. Late in the school year, the third step of the Study was accomplished when the children again checked the List as to their degree of interest in each item.

Step four involved the making of comparisons and the drawing of conclusions. Since the desire for future participation in an activity seems to be a reasonable standard upon which to base a judgment as to a child's real interest in that activity, this was used in the following comparisons. At the beginning of the year, the average number of out-of-school science activities in which these 120 children wished to participate in the future was 20.6; at the end of the year, the average number was 25.7.

	Beg. of yr.	*End of yr.*
Grade 7	16.4	29.0
Grade 8	24.2	28.6
Grade 9	22.3	19.4

While mere *number* of activities is not a guarantee of deep interest, it nevertheless can be used to show desire to continue with old activities and to enter upon new ones.

Now as to more detailed results. We chose for each grade from among the fifty-seven items on the List, all those which had been directly or indirectly connected with the work covered in the grade during that portion of the school year. The Seventh Grade, for instance, had covered units of work on Our Earth, Prehistoric Plants and Animals, Present-day Plants and Animals; and the following items from the List will show the per cent of interest shown by the sixty-one children of the grade, on the basis of their desire for future participation.

	Beg. of yr. %	*End of yr.* %
Helping to train and care for pets	59.0	87.3
Helping to care for farm animals	34.4	60.3
Raising animals for sale.....	31.1	36.5
Taking animals to Shows.....	32.8	46.0
Making deep-sea diving helmets	14.7	26.9
Experimenting with microscope..	40.9	63.5
Drawing, painting, modeling, etc. (Nature subjects)	29.5	58.7
Collecting fossils	24.6	44.4
Collecting minerals and rocks...	29.5	49.2
Collecting insects	13.1	36.5

The 36 children in the Eighth Grade General Science classes had studied Light, Heat, and Electrical Energy during the same period, using Caldwell and Curtis, *Science for Today*.

	Beg. of yr. %	*End of yr.* %
Helping to fix the family car...	33.3	39.5
Helping to fix electrical appliances	30.5	42.1
Making mechanical models.....	16.6	34.2
Experimenting with radio.....	47.2	52.6
Experimenting with chemicals...	66.7	72.7
Taking pictures	86.1	89.5
Developing and printing pictures	75.0	84.2
Enlarging pictures	61.1	71.0
Visiting factories, power plants, radio stations, etc.	69.4	86.8

The 23 children in the Ninth Grade General Biology class had studied the Plant Kingdom, the Animal Kingdom, Human Organism, and Improvement of Living Things during this period, using Hunter's *Problems in Biology*.

	Beg. of yr. %	*End of yr.* %
Helping to choose household supplies	56.5	14.3
Helping to plan menus at home..	34.6	42.9
Helping to plan school lunches..	30.8	14.3
Helping to choose own clothes..	76.9	76.2
Helping to care for garden.....	34.6	47.6
Helping to train and care for pets	53.8	61.9
Helping to choose soaps, toothpastes, etc.	15.4	28.6
Helping to choose home medicines	7.7	9.5
Helping to care for farm animals	26.1	9.5
Raising plants for sale.....	4.3	0.0
Raising animals for sale.....	13.0	4.8
Taking animals to Shows.....	30.8	33.3
Making deep-sea diving outfits..	13.0	23.8
Experimenting with microscope..	65.2	26.6
Collecting flowers	13.0	23.8
Collecting leaves	13.0	19.0
Collecting insects	26.1	38.1
Taking walks to study birds....	26.1	28.6
Helping to choose campsites, water, etc.	56.5	42.9

You will immediately notice the great difference in interest in these items as indicated for the three grades. What causes this difference is difficult to say, although the more sophisticated interests of older boys and girls probably accounts for much of the lessening of desire for future participation as found in the Ninth Grade. Possibly the desire to experience the relatively unknown explains some of the intensity of interest shown in the Seventh and Eighth Grades, and the satisfying of the desire for the experience in class and out, may further explain the results in the Ninth Grade. Whatever the explanation, and granting that other factors such as parental influence, Scout activities, voluntary readings and the like, may also have played a part in the general increase in interest in these chosen items in the three grades, there nevertheless seems to be left a sufficient amount of increase in the desire for future participation to warrant our placing some of the credit upon the science courses in which each child had taken part in the months between the first and second ratings. Therefore, at least from the point-of-view which we have taken for our basis of judgment, we may say that our three-year Science Program is functioning successfully, and that this success is more apparent in the seventh and eighth grades than in the ninth. The final step of the Study is obvious.

The advantages of this plan for determining the efficiency of a Junior High or Senior High School Science Course seem to be these: it can be adapted for any size class, any grade, any type of community, any method of teaching, any subject, the items in the list of out-of-school Science Activities being made to fit into each situation.

A STUDY OF THE GRADES OF THE WEST VIRGINIA UNIVERSITY FIRST-YEAR PHYSICS STUDENTS WITH REFERENCE TO PREVIOUS TRAINING IN HIGH-SCHOOL PHYSICS *

JAMES EARL RUDY
East Fairmont High School, Fairmont, W. Va.

Watkins [1] states, in a report prepared for the National Society for the Study of Education, that physics enrollments have decreased from 1910 to 1928 from 14.9 to 6.9 per cent of the total enrollment in secondary schools.

In a study of high school physics enrollments conducted at Pittsburgh, Seybert [2] found that a great majority of high school students do not enroll in physics because of a lack of interest in the materials presented in the course and a belief of greater difficulty of the work as compared with other school subjects.

For some time the writer has been interested in this decrease in physics enrollments and in the fact that physics is still college preparatory in content and objectives in many of the modern high schools. This interest has naturally led to a desire to know whether students with training in high school physics make better grades in first-year college physics than those students who have had no high school physics.

From the general office of the physics department of West Virginia University the first and second semester grades of the first year physics students for the school-years 1935–1936, 1936–1937, 1937–1938, 1938–1939, and 1939–1940 were tabulated. Withdrawals before mid-semester or later withdrawals of passing students were not counted as cases. Withdrawals late in the semester of failing students, however, were counted as failures.

The grading system at West Virginia University is in letters A, B, C, D, E, and F. In this study the letter E does not appear because it is either changed into some other grade by a condition examination or it automatically becomes F. These letters were given arbitrary values as follows: A-5, B-4, C-3, D-2, and F-1. By giving the letters numerical values the data could be treated more easily and when the results were obtained they could be changed back into letters.

The students' records were checked in the registration office for previous high school credits, and the grades for the first and second semester course in Introductory Physics, commonly known as AB Physics, and General Physics, commonly known as Engineering Physics, were then arranged in two groups, those with previous training in high school physics and those without previous training in high school physics.

In treating the data statistically, the first step was to calculate the mean of each group of physics students. This was done by using the formula: [3]

$$M = \frac{\Sigma fX}{N}.$$

The standard deviation was found by using the formula: [4]

* Abstract of M.A. thesis, West Virginia University, 1940.

[1] Watkins, Ralph K. "Instruction in Physical Science in the Secondary Schools." *Thirty-First Yearbook of the National Society for the Study of Education.* Vol. I; p. 243. (1932.)

[2] Seybert, Reno F. "Analysis of Reasons for Enrollment and Non-enrollment in High School Physics." Unpublished Master's Thesis. University of Pittsburgh. (1937.)

[3] Garrett, Henry E. *Statistics in Psychology and Education.* New York: Longmans, Green and Co., p. 46. (1938.)

[4] *Ibid.*, p. 42.

$$\text{S. D.} = \sqrt{\frac{\Sigma fd^2}{N}}$$

The standard error of each mean was found by using the formula:[5]

$$\sigma M = \frac{\sigma}{\sqrt{N}}$$

Then it was necessary to find the standard error of the difference between the means of the two groups of students taking the same physics course. This was done according to the formula:[6]

$$D = \sqrt{(\sigma M_1)^2 + (\sigma M_2)^2}$$

The ratio between the obtained difference and the standard error of the difference was found by using the formula:[7]

$$\frac{D}{\sigma D}$$

The reliability of the results was then found by referring to a standard error table.[8]

The I.Q. of the student was not taken into account because of the difficulty that it presented in treating such a large number of cases statistically, however, it was believed that due to the large number of cases (2,596) that the results would be fairly accurate.

Since all the students did not come under the influence of the same teacher, it is possible that there may be some variation in the distribution of marks due to teachers of different abilities, personalities, and standards of grading. Then again the students who had selected physics as their field might have worked harder than the students who were not going to major in that subject.

Little is known about the students who have taken high school physics and the students who have not taken high school physics. Some students may have been deprived of the opportunity of taking high school physics, due to the fact that all of the high schools do not offer physics. It may be that a select group has studied high school physics. If this is true, naturally, that group would show up better in college physics.

TABLE I

A COMPARISON OF THE MARKS MADE IN INTRODUCTORY PHYSICS AT WEST VIRGINIA UNIVERSITY BY THE STUDENTS WITH PREVIOUS TRAINING IN HIGH SCHOOL PHYSICS AND THE STUDENTS WITHOUT PREVIOUS TRAINING IN HIGH SCHOOL PHYSICS

	Previous Training in High School Physics		No Previous Training in High School Physics
First Semester			
Mean	3.638		3.363
S.D.	1.019		1.069
σM	0.0505		0.0450
σD		0.0746	
$\frac{D}{\sigma D}$		3.686	

The chances are 100 (99.9) in 100 that the true difference, in favor of the students with previous training in high school physics, is greater than zero.

Second Semester			
Mean	3.779		3.548
S.D.	1.025		1.082
σM	0.0540		0.0493
σD		0.0731	
$\frac{D}{\sigma D}$		3.160	

The changes are 100 (99.9) in 100 that the true difference, in favor of the students with previous training in high school physics, is greater than zero.

The data collected in connection with this study reveals that, during the five years under consideration, 968 students have taken the first semester course in Introductory Physics. Of this number, 406 had high school training in physics and 562 did not. It was also found that 840 students had taken the second semester course in Introductory Physics, of which 359 had high school physics and 481 did not. In General Physics it was found that of 484 students who had taken the first semester course, 274 had high school physics and 210 did not; and of the 418 students who have taken the second semester course in General Physics, 245 had high school physics and 173 did not.

[5] *Ibid.*, p. 201.
[6] *Ibid.*, p. 211.
[7] *Ibid.*, p. 213.
[8] *Ibid.*, p. 213.

The grades made by the students enrolled in these courses were arranged in frequency tables and the necessary calculations made. The results of these calculations are shown in Tables I and II. Furthermore, the distribution of marks made by the two groups of students in each physics course is shown in Tables III and IV.

TABLE II

A COMPARISON OF THE MARKS MADE IN GENERAL PHYSICS AT WEST VIRGINIA UNIVERSITY BY THE STUDENTS WITH PREVIOUS TRAINING IN HIGH SCHOOL PHYSICS AND THE STUDENTS WITHOUT PREVIOUS TRAINING IN HIGH SCHOOL PHYSICS

	Previous Training in High School Physics		No Previous Training in High School Physics
First Semester			
Mean	2.774		2.414
S.D.	1.006		1.084
σM	0.0607		0.0748
σD		0.0963	
$\frac{D}{\sigma D}$		3.727	

The chances are 100 (99.9) in 100 that the true difference, in favor of the students with previous training in high school physics, is greater than zero.

Second Semester			
Mean	2.730		2.531
S.D.	1.077		1.151
σM	0.0688		0.0875
σD		0.1113	
$\frac{D}{\sigma D}$		1.788	

The chances are 96 in 100 that the true difference, in favor of the students with previous training in high school physics, is greater than zero.

From this study it was found that as far as grades were concerned the students at West Virginia University with high school physics training did better in first year college physics than the students without previous high school physics.

It might also be concluded that, since the difference between the means for the first semester's work is greater than the difference between the means for the second semester's work, the advantage held by the student with training in high school physics becomes less significant during the second semester.

In view of the results of this investigation, the writer feels justified in recommending that high school physics be taken by pupils who plan to take physics in college. This does not mean that the high school physics course should be strictly college preparatory. It is the belief of the writer that the high school physics course can be made valuable to high school pupils who do not plan to enter college as well as to those who are planning to enter college. This means that a course in high school physics should not only help prepare the pupil for college physics, but should be practical enough to appeal to pupils who are not going to enter college.

It is the hope of the writer that because this study has shown that previous high school physics does help the first year physics student at West Virginia Univer-

TABLE III

DISTRIBUTION OF THE MARKS MADE IN INTRODUCTORY PHYSICS

STUDENT GROUPS	PER CENT MAKING VARIOUS GRADES				
	A	B	C	D	F
First Semester (With High School Physics)	23.7	31.5	31.5	11.6	1.7
First Semester (Without High School Physics)	15.3	31.5	31.8	16.9	4.5
Second Semester (With High School Physics)	29.5	31.7	27.6	9.5	1.7
Second Semester (Without High School Physics)	22.5	29.9	31.4	12.5	3.7

TABLE IV

Distribution of the Marks Made in General Physics

Student Groups	Per Cent Making Various Grades				
	A	B	C	D	F
First Semester (With High School Physics)	5.5	15.7	40.5	27.4	10.9
First Semester (Without High School Physics)	4.8	9.5	30.9	31.9	22.9
Second Semester (With High School Physics)	5.3	16.7	39.2	23.3	15.5
Second Semester (Without High School Physics)	5.2	13.9	34.1	22.5	24.3

sity, that the secondary teacher of physics will not be contented with physics as it is today, but will constantly try to improve upon his work in an attempt to give his classes the best of every phase of high school physics.

STATUS OF NEBRASKA SCIENCE TEACHERS

Wayne Nicholls

Principal, High School, Fairmont, Nebraska

In the Spring and Summer of 1940, an attempt was made to find the status of the science teachers in Nebraska Public High Schools. The work was done as a part of the requirements for a Master's Degree in Secondary Education at the University of Nebraska and was done under the direction of Harold E. Wise, Professor of Secondary Education at the University.

In Nebraska, the average high school enrollment is quite small. Teachers of science classes, usually, are teachers in other subject-matter fields as well. Because of this, any teacher who taught any science class or classes was listed as a science teacher. We felt this was justifiable since Nebraska is one of the States which have a "blanket teaching requirement" set-up and all teachers are thus considered "qualified" in their subject-matter fields.

Data for the study were obtained from rather complete reports which the high schools had made to the State Superintendent's office. Complete training and experience records for all teachers were also obtainable. No attempt was made to study trends but the study was confined to data for the 1939–1940 school year. Only public senior high schools were included.

The following phases of teacher status were considered:

1. Official positions of science teachers. (Superintendents, principals, teachers.)
2. Sex of science teacher.
3. Subject-matter combinations.
4. Time spent in science instruction per day.
5. Pupil loads.
6. Experience and tenure.
7. Degrees held and type of college attended.
8. Graduate credit.
9. Salaries.
10. Extra-curricular activities sponsored.

A total of 662 science teacher records were studied. Records on the various phases were available for over 94% of the teachers with the exception of extra-curricular reports which were given for only 75% of the teachers. Records on the largest high schools were not available as schools employing more than 30 teachers in high school are not required to make full reports.

Within the study, the teachers were further classified as to the size of enrollment of the schools in which the teachers worked. It is sufficient to note here that about 60% of the high schools of Nebraska had an enrollment below 100.

If the modal figures of the various phases of the study are used as an index, we may say that the typical science teacher in Nebraska is a man who teaches mathematics in addition to science, has a Bachelor's degree from a State Teachers College of Nebraska, coaches athletics, has had between six and seven years of teaching experience, has been in his present position three and one-half years, has no administrative duties in connection with directing the school in which he works, receives a yearly salary of $1145.49 and has had no graduate work.

Closer consideration reveals the following conditions:

1. Men outnumber women by 5 to 1 among science teachers of Nebraska.
2. Sixty-four per cent of the high schools of Nebraska have only one science teacher.
3. Fifty-two per cent of the science teachers of Nebraska teach in one other subject-matter field, 32% teach in two other fields, 4% teach in three additional fields and 12% teach science classes only.
4. Mathematics is the field most often listed with science.
5. The average time per day spent in science instruction is 97 minutes.
6. The mean daily pupil load (in all classes) per teacher is 76 pupils.
7. Only 46% of the total pupil load of science teachers are in science classes.
8. While the range of years of previous experience is from 0 to 40 years, the average for all science teachers is only 6.9 years.
9. Thirty-four per cent of the science teachers were "new" in their positions.
10. The range of years science teachers have been in their present positions, is 1 to 32 years. The mean is 3.5 years.
11. Eleven and four-tenths per cent of the science teachers were teaching their first year.
12. Twenty-two and five-tenths per cent of the science teachers had moved from one school to another last year.
13. Bachelor's degrees were reported by 86% of the teachers, 14% held Master's degrees and one teacher reported a Doctor of Philosophy degree.
14. Forty-three per cent of the teachers received their degrees from the State Teachers Colleges of Nebraska, 35% from the Church Colleges of Nebraska and 20% from the University of Nebraska.
15. Forty-seven per cent of the teachers reported no graduate credit and 13% had more than thirty graduate hours.
16. Salaries ranged from $630 to $2400, with the mean at $1145.49 per year.
17. The mean annual salary for men was $1184.83 while that for women was $950.32.
18. Seventy per cent of the science teachers sponsor one extra-curricular activity outside of regular school hours, while only 14% sponsor no outside activity.
19. Boys' athletics is the activity listed most frequently as being sponsored by science teachers.

In almost every phase studied, such as salary, experience, tenure and degree held, the situation of the superintendents who were science teachers, was better than those of principals and teachers. It may be, then, that teachers will be attracted toward the administrative part of school

work and away from science teaching as their major endeavor, for it has been shown that salary alone is one of the major factors which determine tenure, transiency and experience patterns. If the trend is toward administrative positions, it must follow that the professional position of the science teacher will become of less importance. While the salaries paid to science teachers in the largest schools may compare favorably with the salaries of administrators in smaller schools, it is equally true that there are but few science teachers in large schools where vacancies very seldom occur, due to better salaries and longer tenure.

While no comparison is attempted between science teachers of Nebraska and all teachers of all subjects in Nebraska or the nation as a whole, it does seem that the status of the science teacher in Nebraska is not particularly attractive either to experienced teachers or to prospective teachers.

A STUDY OF A MICROPROJECTOR AS A TEACHING AID

EDITH BRECHBILL
College Park, Maryland

Since a considerable part of a general biology course involves the study of microscopic organisms and sections of tissues, a question arises concerning the efficiency of different methods of teaching this portion of the course. Microscopes have been used with varying degrees of success. Their high cost has frequently prevented schools from buying them in sufficient quantity, or even at all. A paucity of instruments available in a large class would tend to reduce the study of microscopic materials.

Recently some teachers have utilized means of projecting upon a screen the image of microscopic material. The methods of projection have varied from the use of a lamp placed so that a beam of light shines through a microscope and terminates in an image on the ceiling or side wall, to the use of an especially designed instrument with a clock-work feed arc lamp, a water cooling cell, and an adjustable prism which places the image in any desired location. This method of studying the images of microscopic materials projected upon a screen is advantageous in economy of time, reduced expense, and uniformity of subject matter taught. Questions have arisen, however, about disadvantages of this method. Among these alleged disadvantages are the difficulty of obtaining high powered magnification with the projector; the reduction of individual laboratory work when slides are projected; and the loss to pupils of skill in the use of a microscope, and appreciation of it as a scientific instrument.

A study conducted in 1939 and 1940 by the writer at the University of Maryland compared the learnings of high school pupils who had viewed microscopic materials projected upon a screen with the learnings of pupils who had observed the materials directly through microscopes. No attempt was made to eliminate sources of learning other than the slides. All pupils concerned in the experiment had available texts, charts, and blackboard drawings, and heard frequent discussions and descriptions by other pupils and by the teacher. Thus considerable learning could have been acquired even though the slides themselves had not been studied.

The opportunities to learn from these sources were as nearly as possible equal in the classes in which microscopes were used and in those in which the microprojector was used.

This experiment was conducted four times in two successive years, and in two senior high schools. Miss Mabel Barkley taught all the classes concerned in one school, Central High School, Washington, D. C.; the writer taught all the classes concerned in the other school, Montgomery Blair High School, Silver Spring, Maryland. In Montgomery Blair High School, nine or ten microscopes were provided for each class of approximately thirty-five pupils. In Central High School, each of the thirty-five pupils in a class was provided with an individual microscope and slides.

An objective test, designed to measure learnings from microscopic material observed, was constructed for each of the four experiments. The reliability coefficient of each test was determined by the split-half method and corrected according to the Spearman-Brown Formula. The corrected reliability coefficients of the tests were found to be .77, .88, .88, and .94. The same test was used as a pretest and again as an achievement test for each group. The differences between the scores of the pretest and achievement test were used to compare learnings from the two methods of teaching.

The length of time required for study of the unit was the same in the control groups which used microscopes and in the experimental groups which used the microprojector. Both groups were taught by methods as nearly identical as possible with the exception of the single experimental factor.

In each of the four experiments, two classes, the control group, observed material through microscopes, and two other classes, the experimental group, saw material projected upon a screen. In each case, the equivalent group method was used for comparing results. Pupils in the control group were paired with those in the experimental group according to I.Q. and age. The difference in I.Q. for the two members of a pair in most cases was four or less. The two members of a pair in no case differed more than one year in recorded age, and more often than not were of the same recorded age. The sixteen classes involved in the entire experiment included about five hundred and fifty pupils, of which three hundred and eight were fitted into the two equivalent groups.

No test scores were used except those of pupils who could be fitted into pairs. In two of the four experiments, the average gain in learning was higher in the experimental group; in the other two, the greater gain was made in the control group. In none of the cases, however, was the difference between the two groups sufficiently great to be significant.

These data are shown in the accompanying table, and depicted graphically in Figure 5. While in no case, is the difference statistically significant, there is a slight preponderance of evidence in favor of the experimental method.

Although no comparison was made between the efficiency of learning with individual microscopes, and with nine or ten microscopes to a class of about thirty-five pupils, it is interesting to note the similarity of results in these two cases. In one experiment, the experimental group which used the microprojector showed greater learning than the control group in which each pupil was provided with a microscope; while in another experiment, the control group using individual microscopes showed greater learning than the experimental group. Corresponding results were found in the two experiments in which the control group had a limited number of microscopes.

In three of the four experiments, the individual gains in learning were more

widely scattered in the control than in the experimental group. It is not a surprising result that learning was generally more uniform in a group of students all of whom observed an image on a screen and heard a description of it given by the teacher than in a group in which each pupil was caring for his own instrument. Greater variation in individual learning would be expected in a group in which pupils adjusted their own microscopes, and slides, interpreted parts of the material studied, and decided upon the desirable length of time for observing the object.

A cursory inspection of results such as those found in this experiment would seem to indicate that children learn structures equally well, whether the visual aid be microscopes or a microprojector. This may or may not be true. Other sources from which learning accrues are available in classes to an extent that knowledge of size, shape, and names of structures can be gained without a study of the slides.

Although the results of this investigation indicate that little more factual learning is acquired from one method of observing microscopic material than from another, it is possible that there are significant differences in desirable outcomes, other than the learning of names and appearance of structures. Some of these outcomes were suggested by comments of students in the experimental group at Central High School, Washington, D. C., who had previously used microscopes. Some of their reasons for preferring the microprojector were:

"You can see more and better."
"The teacher can point out the parts better."
"It shows things more clearly."
"There is less confusion in the room."
"You don't have to bother with too few slides to go around."
"The slides are enlarged more."
"It doesn't take as much time and material."
"When you use the microscopes, it takes too long for the teacher to get to each pupil."
"It's easier to see an object moving when the teacher regulates the slide."
"It's easier on the eyes."

Some of the reasons for preferring microscopes were:

"You seem to see the objects closer and more clearly."
"It gives you more chance to do individual work."
"You learn how to use a microscope."
"When the projector is used, time is wasted in fixing it, changing carbon rods, etc."
"When you study from a screen in front of the class, there are too many other things in the class to watch."

A large preponderance of student opinion revealed preference for the microprojector over microscopes. Regardless of value as an independent learning aid, it is reasonable that both of these visual instruments are useful for increasing interest and the sense of reality—and it seems that the microprojector is the more effective for most people in discharging these functions.

The microprojector is more desirable from a financial standpoint. This instrument, completely equipped, costs a little

TABLE I

MEAN GAINS AND DIFFERENCE OF THE MEANS IN EACH EXPERIMENT

	Mean Gain		Difference of the Means (Experimental minus Control)	Standard Error of the Difference
	Experimental Group	Control Group		
Experiment I	37.59	39.63	-2.04	3.60
Experiment II	23.51	18.92	4.59	2.42
Experiment III	31.46	29.03	2.43	1.64
Experiment IV	33.13	33.96	-0.83	1.80

more than two hundred dollars. (The exact cost varies according to quantity and type of equipment used.) The cost of a microscope of standard quality for use in biology classes is approximately eighty dollars. The expense of equipping a class with the minimum number of microscopes used in this experiment (nine) would be about seven hundred and twenty dollars. The expense of equipping a class with the maximum number used in this experiment (thirty-five instruments for a class of thirty-five pupils) would be about two thousand five hundred dollars. Additional expense is incurred in the use of individual microscopes by the necessity of providing more slides. If this experiment truly reveals the relative efficiency of the two instruments, the wisdom of equipping a class with individual microscopes would seem doubtful from a financial consideration.

A microscope is more satisfactory for observing specimens which require a high degree of magnification. A high-power, objective lens used with the microprojector decreases the amount of light to such an extent that the image on the screen cannot be seen clearly at a distance of several feet.

A class is more easily conducted when one slide is viewed and studied on a screen than when students study different slides, read, or write at various places in the room. In situations in which maintenance of order is difficult, this may be an important consideration. Uniformity of activity, however, may not be wholly advantageous. It was noted in a comment by several pupils that individual activities are desirable, and are provided by the use of microscopes better than by the use of the microprojector.

The data gathered in these experiments furnish an opportunity to present evidence on the relative efficiency of these two methods of teaching children of high and low mentality. All pupils who took both pretest and achievement test were divided into three groups, according to I.Q. Thus it was possible to determine whether the microprojector or the microscope was a more effective instrument of learning for pupils of high, middle, and low mentality.

The intelligence quotients of pupils in the low group was below 100; in the middle group, was from 100 to 110; in the high group, was above 110. The average gains in learning were found for the control and for the experimental groups in each of the three intelligence levels. The results of this part of the investigation were so contradictory that the differences cannot be considered substantial. Furthermore, the differences were slight in each part of the experiment in which there were ten or more persons in each group. We may conclude that neither the microprojector nor the individual microscope shows marked superiority as a teaching instrument in groups of any particular intelligence level.

It is the writer's considered opinion, in the light of the results of this experiment, and observations made at that and other times when microscopic materials were being studied in class, that best teaching might be done if a method were adopted which combined the use of the two instruments. Some skill in the manipulation of a microscope and appreciation of its use seem to be unquestionable assets for students of biology. An acquaintance with the general appearance of a slide, gained by observation of the image thrown upon a screen by the microprojector, would place a pupil in a better position to recognize and understand the material later, when he was given an opportunity to study it under a microscope.

The only other investigation in this field of which the writer is aware is one conducted by Allan Stathers at the University of West Virginia in 1932. In this earlier study, the groups using a microprojector showed definite superiority in learning over the group using individual microscopes.

THE FIFTY-FIVE MINUTE CLASS PERIOD FOR GENERAL SCIENCE

G. M. Rawlins, Jr.

Head, Department of Science, Divisions 1-9, Public Schools of the District of Columbia

The junior high school in the last twenty years has become an accepted part of the organization in many school systems, especially in large cities. During this time marked changes have occurred in educational philosophy. The earlier concept of education considered it largely a process for learning subject matter, but this is being replaced with the idea that education should further the growth and development of the individual. Integration of personality and successful adjustment to the environment are among the present goals of education. This newer philosophy has been influenced by the experimental work of psychologists who generally agree that growth is a gradual and continuous process which begins in infancy and extends throughout life, and that an individual is constantly interacting with his environment and gradually developing or unfolding mentally, physically and emotionally. To meet the needs of such development, the program of instruction must be both dynamic and continuous. The most frequently accepted objectives of science instruction arising from the newer philosophy of education are (1) to give the students a fundamental understanding of the major generalizations and principles in the field, (2) to afford training in scientific methods, and (3) to inculcate scientific attitudes.[1]

The pattern for the early junior high school was naturally taken from the four year high school and was based upon the concept of homestudy with subsequent classroom recitation. With the development of educational philosophy this concept is changing, but the structure of the school organization remains much the same in many systems, as the day is divided into forty-three minute periods for recitations.

Where the fifty-five minute period is introduced in the junior high school an attempt is being made to change the structure of its organization. It is believed that this will tend toward a more efficient functioning of the educational processes, for it makes possible greater student participation. The actual solving of real problems in class should assist pupils in attacking the problems of life. The teacher should not lose sight of the fact that youth is being prepared to live the fullest life which their potentialities permit.

General science is now considered a junior high school subject in schools reorganized on the 6-3-3 plan, and in many such systems is frequently offered in the seventh, eighth and ninth grades, with one or more years being required for graduation. In schools operating on the 8-4 plan, general science is usually a ninth year subject. Teachers have difficulties in general science, as in all other areas of the curriculum. Experience shows that among the most important of these are the following:

1. Many pupils read very poorly.
2. Textbooks are frequently too difficult because of their vocabularies or the style of the author.
3. Too much subject matter is included in many courses of study.
4. Pupils do not know how to study.

A pertinent question for the science teacher is: "Will the fifty-five minute period help solve these problems If so, the advantages and possibilities of super-

[1] National Society for the Study of Education, *Yearbook XXXI*, Part I, "A Program for the Teaching of Science," Public School Publishing Company, Bloomington, Ill., 1932, pp. 41–57.

vised study will be largely responsible. The teacher should not use the longer period entirely for review and discussion on those days when there is no demonstration, or when pupils are not working in small groups, but it should provide opportunity for the guidance of pupils as they acquire proficient study techniques. Several plans for supervised study have been advanced. The one designated as the "flexible divided period" probably is most useful for science instruction. Under this plan about twenty-five minutes at the beginning of the period may be used for review and discussion, ten minutes for an assignment, and the remaining twenty minutes for supervised study. These time limits are, as indicated, only suggestive. A demonstration by the teacher, work carried on by individual students, or by small groups may require the entire period.

Beauchamp [2] showed in his study as early as 1923 the advantages of directed study, but even now the procedure is used very ineffectively by too many science teachers. We generally excuse ourselves by saying the time is too short and there is so much material to cover, but with the lengthened period this alibi is less valid. Some teachers possibly think they are conducting supervised study when they assign a reading exercise and sit at their desks and correct papers, but children require much more assistance than this if they are to benefit materially by supervision. This procedure is little more effective than a study hall presided over by a teacher who is not a specialist in more than one or two fields. It is time we give some real attention to improving the study habits of our pupils and also assist those who have difficulty because of poor reading ability. Experience has shown that all teachers should attempt to remedy such defects and not leave it to one department as reading has been left too frequently to English.

Space does not permit a discussion on assisting pupils to form proper study habits or how reading may be improved. There are numerous articles and several books in each field which should assist teachers in this matter. Crawford's [3] book, *The Technique of Study* impresses this writer as being very helpful, and the New Jersey Secondary School Teacher's Association [4] has issued an inexpensive *Handbook on Reading for All Teachers of Secondary Schools* which contains many valuable suggestions for teachers whose pupils need help in reading.

Teachers, because they feel less hurried with longer periods, should develop a greater interest in the problems of individual children and think less of covering a specific number of pages in a textbook. Even though less subject matter is covered, it is very probable that pupils will learn scientific principles just as effectively, that more training in the use of the scientific method will be given, and that the scientific attitude will be even more firmly established. No one questions the desirability of learning factual material, for it is needed to clarify and emphasize principles, but too often we have taught as if the main objective was to create a human encyclopedia. It is probably the indiscriminate use of all materials in the course of study which seemingly makes it appear too long.

The weaknesses of some texts may also be ameliorated by the lengthened period, as teachers will have more time for using supplementary books and pupils may find the desired subject matter presented in a more understandable fashion. If teachers feel less hurried by subject matter objectives they will also spend more time in

[2] Curtis, Francis D., *A Digest of Investigations in the Teaching of Science.* P. Blakiston's Sons & Company, Philadelphia, Pa., 1926, pp. 75–85.

[3] Crawford, Claude C., *The Technique of Study.* Houghton, Mifflin Company, New York, N. Y., 1928.

[4] The New Jersey Secondary School Teacher's Association, *A Handbook on Reading for all Teachers of Secondary Schools,* 1936.

assisting pupils to learn the technical vocabulary of general science. This will not only improve reading ability, but will make texts more understandable, will stimulate interest, and may improve study habits. Too often we forget that words which are simple to us after years of use are still vague or entirely meaningless to pupils at the end of a unit, and are anything but stimuli to the child's interest.

From the student's point of view, additional advantages of the fifty-five minute period are fewer teachers during a day, less nervous strain incident to more frequently changing rooms and climbing steps, with shorter periods, less homework, and a greater variety of activities during the class period.

Much better articulation is secured between the elementary and the junior high school, especially in the seventh grade, if the child has fewer teachers. The break is rather severe when a child who is accustomed to spending the day with one teacher comes to the junior high school and has possibly five or six different instructors. Even if the longer period should not reduce the number of teachers for the week, it will cause a daily reduction.

Almost any one of mature years will gladly discuss the differences in the home life of the present and that of their youth. It is generally conceded that many children have no place to study except the family living room where there is distracting conversation and probably a radio program simultaneously. Parents frequently have neither the time nor inclination to supervise the lessons of two or three children, and if they do this, they should not be as competent for the work as the trained teacher whose profession it is.

Other advantages of fifty-five minute periods include fewer pupils to whom the teacher must adjust, as there should be only four classes each day instead of five. This is a real advantage, too, for general science classes frequently have more than forty pupils in them. Five such classes a day is a load for the conscientious teacher who tries to care for individual differences, familiarize herself with the child's home life, direct a section, and perform other duties which are ordinarily labeled extra-curricula, but which really are a part of the regular school life. Fewer classes also means less hall duty as there are fewer changes made.

Some teachers believe that longer periods will cause classes to become more restless thereby giving rise to discipline problems. This should not occur as an interested child is never a discipline case, and a longer period with diversified activities will lessen discipline requirements, as greater pupil participation will mean more interest. Then, too, as pupils receive helpful individual instruction they may realize more fully how interested the teacher is in their welfare. Many pupils probably never appreciate the fact that their instructors are striving to prepare them for useful citizenship. The efforts of some teachers in this matter may be misguided and ineffective, but the intention is there without doubt. It is very essential that pupils regard teachers as being human, sympathetic and helpful and not as task masters or unreasonable individuals. The proper teacher-pupil attitude in the classroom repays the teacher who strives for and cultivates it manyfold.

There are possibly weaknesses which can be discovered in the fifty-five minute organization, for few plans are perfect. Teachers may question the total time given general science per week with longer periods. If classes ordinarily meet either four or five times a week with forty-three minute periods and change respectively to three or four fifty-five minute periods the difference is not significant. The philosophy of the fifty-five minute period is neither to gain nor lose in allotted time, but to assist in making the teachers' work more effective during the classroom period.

Editorials and Educational News

FOURTEENTH ANNUAL MEETING OF THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

Hotel Claridge, Atlantic City, New Jersey
February 23, 24, 25, 1941

The National Association for Research in Science Teaching held its fourteenth annual meeting at the Hotel Claridge, Atlantic City, New Jersey, from February 23rd to 25th, 1941. At the Sunday evening meeting which is open only to members, Mr. Harry Carpenter, the president, presided. The meeting was opened with an address by the president after which routine business matters were transacted. These included the annual report of the secretary-treasurer and reports by the various committees.

The morning session on February 24th convened in the East Room of the Hotel Claridge. Following a short business meeting, the various Area Committees of the Association met for deliberations and reports of progress.

Many of the members attended a joint luncheon with the Department of Secondary Teachers of the N.E.A. at which time Mr. Harry Carpenter delivered an address.

The afternoon session of the Association was convened in the East Room of the Hotel Claridge, Mr. G. P. Cahoon presiding.

A very interesting and stimulating paper was presented by A. N. Zechiel, curriculum consultant of the Committee on the Relation of School and College of the Progressive Education Association. His topic was, "Needed Research in Science Education." Following this paper there was a panel discussion of the topic, "The Science Workshop: Its Purposes, Methods and Effectiveness." The panel was comprised of the following:

W. C. Croxton, State Teachers College, St. Cloud, Minn.

J. Wallace Page, Director Maryland Academy of Sciences, Baltimore, Md.

A. O. Baker, Chairman High School Science Curriculum Center, Cleveland, Ohio.

Clark W. Horton, Dartmouth College, Hanover, N. H.

A. N. Zechiel, Curriculum Consultant, Committee on Relation of School and Colleges, P. E. A.

O. S. Loud, Bureau of Educational Research in Science, Columbia University, New York City.

The morning session on February 25th was convened in the Solarium of Hotel Claridge. The president presided over a short business meeting and then turned it over to Mr. G. P. Cahoon who introduced the following speakers and their topics:

Evaluation of Broadcasts and Recordings for the Classroom by J. R. Miles, Bureau of Educational Research, Ohio State University and

Experiences with a Junior Academy of Science by E. S. Obourn, John Burroughs School, Clayton, Mo.

ELLSWORTH S. OBOURN,
Secretary-Treasurer

MORE PROMISING PRACTICES

Since describing in our January issue certain new practices in science teaching, we have received additional statements worthy of the attention of our readers.

Integrating science and social studies. Much will be said and written in the immediate future years concerning practices in the integration of "core" and "elective" subjects in the secondary school curriculum. The movement has gone forward in scattered centers for some time. Further

experimentation and evaluation will provide data to judge the values of such procedures. Science teachers and supervisors will participate in the problem in a truly scientific attitude, we trust.

An attempt at the study of one aspect of the general problem is described in the following statement by Earl C. Wolfe, head of the Science department, sent us by Principal Clarence W. Johnson, of the Downers Grove Community High School, Downers Grove, Illinois.

Science is an important part of most human problems. In the study of human problems, social science courses usually omit the science phases. On the other hand, the science courses often do not relate their findings to the large social problems.

To offset this partition in subject matter, a freshman class in Downers Grove High School works together for three hours per day on problems which are not separated into subject matter divisions. Three teachers with training in different fields cooperate in directing the work. In areas including problems of school, community, home, and self exploration, the students and teachers together collect, organize, and then subdivide units of work until each student is developing a personally interesting aspect of a major problem for which he is responsible to the rest of the class.

The student may solve his part of the problem by reading, interviewing, visiting industry, or experimenting in the laboratory. In his laboratory hour no attempt is made to exclude social aspects of his study, and in the social science library, science material and scientific procedure are encouraged. In fact, at no time is there a segregation of the science, English, or social phases of the problem.

When the solution of a problem includes an experiment, the student and the teacher plan together the method of procedure. The student may experiment for his own information, he may demonstrate as part of his report, or he may direct the class to experiment individually. For example, in a study of natural resources, one student read extensively on oil refinement. With the help of a senior science student he set up a fractional distillation of crude oil. Continuous operation of this "plant" for several days presented this process more clearly than words or pictures. Another boy studying ceramics found that several kinds of clay are used. He learned simple methods of testing these clays, and then had each student in class conduct these tests. Scores of such experiments are performed without repetition. These experiments are not previously organized or standardized, but are developed to aid the student in understanding and solving his particular problem. Only the nature of his problem determines what experiments he performs.

Comparison of students of this class with those of traditional general science classes as revealed by the standardized testing program shows them to be about equal in factual information gained. These students contact a wider variety of science problems than usual. The advantages of their experiences in planning and organizing are evident in later class work. These students learn the practical use of the scientific method in spite of inadequate data. In finding their problems, these students sense the application of science in broad social problems.

Another type of integration of science. Major problems of living, or life activities, are often large in scope calling for reference to different areas of human endeavor, or subject fields. Such problems or activities are common in the elementary school curriculum. In recent years, there has been an increasing number of attempts to employ similar plans of organization in junior and senior high schools.

An interesting variety of this kind of experience with the curriculum is illustrated in the Demonstration High School, West Virginia University. The statement concerning the practice there employed on an experimental basis is furnished by George A. Federer, Jr., Coordinating Teacher, Science Department.

For a number of years an experimental group of ninth-grade pupils have been starting the first year in high school by working for two hours during the day with one teacher.* During this two-hour period, the teacher, with the group, agreed upon a central topic or theme for study. Following the selection of the topic the pupils were given the opportunity of spending an hour every other day with the science teacher. One theme selected under this particular plan was entitled, "Know Your School."

The general science class approached this topic in a direct manner by giving consideration to the scientific problems about the school building and the campus. The materials used in the construction of the school building such as the flooring, the decorative marble, brick, spouting and insulating materials were studied. In many cases samples of these materials were obtained from the manufacturing companies with literature explaining their properties. Visual aids were used where possible so as to give the pupil the com-

* (See previous account of this procedure by George H. Colebank. Bulletin of Secondary School Principals, October, 1940, page 81.)

plete picture of the methods by which the materials were made. An estimate of the cost of fuel for the building was made with consideration of the by-products that are lost from the furnace. A rather complete investigation of the heating and ventilating system was carried out. Frequent field trips were made about the extensive campus in which the class studied the trees, plants, seeding the lawn, flowers, strata of rock and soil erosion. In considering the beautification of the lawn one pupil suggested the construction of a sundial similar to the one which she had observed pictured in a book. This bit of construction was a wonderful learning situation within itself.

Books were not used in formulating these exercises, but instead, they were used as aids in solving the problems. Constant alertness on the part of the pupil towards the explanation of the science involved in his environment is very commendable with this type of curriculum.

Learning and serving by doing in science. It has required a long time for too many teachers of science to relate functionally their subject content with real, personal and social living. The curves of percentage of enrollment of secondary-school pupils in the oldline sciences speak forcibly the results of academic-minded teachers. The awakening—shall we say, resurrection—may be coming. More and more we hear of evidence of its approach, even though visitation of high-school science classes fails, at times, to provide highly encouraging hope.

"Thinking inheres in action" is a guiding principle that progressive teachers have heard and practiced. We have far to advance in dynamically accepting the motto in our science teaching. A brief statement, prepared by James M. Martin, head of the science department of Ellerbe High School, Ellerbe, North Carolina, and sent us by Principal Richard F. Little of that school, shows how one group of students is guided in functional learning.

Every effort is being made at Ellerbe to make high school science courses of a practical nature, in the belief that "Ellerbe students learn by doing." Thus students of a general science class, while studying a unit on light and home illumination, drew plans for the arrangement of the new science laboratories in order to insure obtaining the maximum amount of natural illumination as well as artificial light from the already existing fixtures. The value received from this project has not limited itself simply to subject matter but has revealed itself in the pride and joy which these students manifest in having had a part in the planning of their new science rooms as shown by their care of them.

While studying the skeletal system, the biology classes felt the need for some sort of animal skeleton to use in their class work. As this type of material is expensive, and the school funds at Ellerbe are very limited, no solution seemed possible. Then a student spoke of having seen a large dog skeleton in a wood while out hunting. A field trip was taken to this wood and the bones collected. Back in the laboratory these bones were carefully cleaned, bleached, and mounted. The finished product was a skeleton that would serve the use of any high school as well as the most expensive commercial skeleton obtainable. When the project was completed, the students were surprised to find that they not only knew the names of more bones than their text suggested they learn, but also had obtained an impression of the relationship of the skeleton to the internal organs and the muscles of the body that they would never have received from studying the bones of a skeleton already assembled.

The science department was desirous of a radio. Again the problem of money had to be confronted. A physics class decided that, while studying their unit on radio, they would attempt to build a receiving set. Several discarded radio sets were contributed by interested people in the community. With the parts obtained from these a small serviceable radio was built for the department. So great was the carry-over of this unit that several students who did not have radios at home decided to build sets for their families. With the cooperation of the local radio dealer, who was only too glad to get rid of some of the old worn-out radios in his warehouse, two boys, without any supervision, built larger sets of which they justly had a right to be proud.

It is the aim of the science department to correlate its work with that of other departments in the school. While one English class was studying a unit on the telephone, the physics class likewise began a study of this instrument. Ellerbe's students, being from a rural community, have little opportunity to use or understand a telephone. With this fact in mind the physics class visited the local telephone office and later was given several discarded telephone units. By salvaging all usable parts, two working telephones were installed in English classrooms, forming an intercommunication system for the use of that department in its telephone units. Thus it is that Ellerbe science students not only learn but also serve by doing.

Filling the vacation gap. It has often been said that the best measure of success of a course is the voluntary activity performed by the student after the course "is

completed." Too often, the study of science closes with the completion of the last chapter of the textbook. "I passed, that's done," takes the place of "Now, we can go on to new levels of activity and accomplishment."

The quotation below, prepared by Edward Flickinger, science teacher, and sent to us by J. Leroy Thompson, Superintendent, Washington Irving Schools, Tarrytown, New York, suggests a kind of vacation activity in science which has undoubted merit and which might prompt other teachers of science to carry on.

During July pupils of the Washington Irving Schools in Tarrytown, New York, enjoy the privilege of learning more about the branch of Science in which they are interested. Classes under regular instructions from 9–12 o'clock in the morning five days a week with one or two afternoon field trips every week, round out a month of, shall we say, "intellectual enjoyment" for all concerned. With no assignments, no attendance records and no examinations many have inquired as to just what is done.

On the first day the pupils are asked to crystallize their scientific interests in one definite area. It is here that careful thought on the part of the instructor determines the success or failure for the session. With children from fourth grade through the post graduate level in one group the problem at first seems impossible. But one or two examples will show that this wide age range is really an asset.

Last summer a High School Senior, a fourth-grade girl and a sixth-grade boy wanted to learn more about Hydroponics, or the soilless growth of plants. The three people co-operated very nicely, the Senior learning by teaching the younger people who mastered the technique of the process with apparently little effort. The Senior enjoyed himself trying out new formulas, various methods of aeration, etc. Field trips through the Boyce-Thompson Institute at Yonkers, N. Y., and a commercial water-culture "farm" in a nearby village were revealing as to the amount of information the pupils had gathered and applied. Their questions evidenced a wide and definite knowledge of the subject.

Another example was the Photography group, which numbered twelve pupils at different age and informational levels. Their daily round table discussions on the result of the previous day's work brought about a mastery of the simplest elements involved for even the youngest, whereas the older people were stimulated by having to diagnose and prove to the younger people where the trouble originated. Their work in reducing and intensifying negatives; their enlarging, dodging and cropping on different grades and quality papers, with different exposure and developing times, instilled deeply lessons which will not soon be forgotten.

Case after case could be cited in radio, microscopic work, mineralogy, etcetera, to show the practical value of this type of schooling. There seems to be some indication that the grouping of different age and informational levels together are of distinct value. The older people are inspired to further learning by the many questions of the younger group whereas the younger groups are more free and open with their questions to high school people than they would normally be to adult teachers.

It is only natural for pupils to work hardest at the thing they find most interesting. Is it not therefore the responsibility of our educational systems to guide these children in their chosen interests without the more or less formal disciplinary routine of the regular school year? This type of summer school seems to fill that gap.

By inference and example one can readily see that the plan is wholly individual instruction, the students gaining in terms of their interest and ability.

SUMMER CONFERENCE OF THE NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS

Following two very successful Summer Conferences, the New England Association of Chemistry Teachers is making plans for the Third Annual Conference to be held this summer on the campus of the University of Connecticut, Stoors, Connecticut, on August 12, 13, 14, and 15, 1941. The morning and afternoon sessions will be devoted to invited papers on topics of current interest pertaining to the teaching of chemistry in secondary schools and colleges and to recent advances in the science itself. Speakers of national repute have been invited to participate. Meals and lodging will be provided at a very low rate by the University, and accommodations for families will be available. A social program and industrial trips are being planned.

The Committee is comprised of the following:

Dr. Laerence H. Amundsen, of the University of Connecticut;; Mr. Edward H. Coburn, Bulkeley High School, Cartford, Conn.; Miss Hilda E. Gellerson, Windham High School, Willimantic,

Conn.; Miss Elizabeth S. Hollister, Williams Memorial Institute, New London, Conn.; Dr. Charles R. Hoover, Wesleyan University; Rev. Raymond G. LaFontaine, St. Thomas' Seminary, Bloomfield, Conn.; Mr. Robert W. Neathery, Jr., The Wooster School, Danbury, Conn.; Mr. Donald W. Putnam, High School of Commerce, Worcester, Mass.; Mr. George B. Savage, Chairman, The Loomis School, Windsor, Conn.; Dr. John R. Suydam, St. Mark's School, Southboro, Mass.; and Dr. John A. Timm, of Yale University. The following officers of the Association are also serving on the Committee ex-officio: Prof. Laurence S. Foster, of Brown University, President; Mr. Theodore C. Sargent, Swampscott High School, Swampscott, Mass., Vice-President; and Mr. Frank L. Bridges, North Quincy High School, Quincy, Mass., Advertising Manager of the REPORT of the New England Association of Chemistry Teachers.

There will be a registration fee of $2.00 for members of the Association who register before August 1, and $3.00 for those who register later than this date. For non-member chemistry teachers from New England or elsewhere, the registration fee is $5.00, part of which may be used as dues in the Association if membership is desired. Payment of the registration fee is not required of non-teaching guests and the families of teachers attending the Conference.

For further information, letters should be sent to the Chairman or to members of the Committee.

A NEW VISUAL AID IN CHEMISTRY

In the realm of Science Education, new teaching devices and techniques are constantly being sought for in an effort to expedite the learning processes and enrich teaching methods.

Chemistry jig-saws, or valence blocks, matched together may be used to construct chemical formulae and equations, and solve problems of ionization, valence, etc. Recently these blocks were devised in science class rooms at Baltimore City College as a joint project of pupils and teacher. A set comprises a series of geometrical figures such as circles, squares, rectangles, triangles, and ovals of different sizes with a varying number of arms representing the positive and negative valence of elements or radicals. The figures fit naturally together with arrows and slots, and by reading off the labelled atomic numbers and chemical symbols, such difficult concepts in general inorganic chemistry as ionization, valence, chemical equations and formulae, chemical activity, and the periodic arrangement of elements, etc., are clearly visualized.

Bright chemistry students may find these blocks an economy in learning, while average students may utilize them as the visual means of grasping the difficult fundamental concepts of chemistry. The blocks may be used to play an educational and interesting game similar to dominoes with any number of students or players participating. The complexity of the game will vary with the players' mastery of the science.

Literally thousands of formulas and equations are possible by fitting different blocks together and reading off the results so obtained.

Large sets might be built for blackboard demonstration by teachers, and braille labeled blocks have been used by blind students.

ARTHUR H. BRYAN,
Baltimore City College,
Baltimore, Md.

Abstracts

SCIENCE EDUCATION

STICKLER, W. HUGH. "Opaque Projection in Biology." *The American Biology Teacher* 3:11–14; October, 1940.

The amount of opaque material which can be projected advantageously is almost unlimited and the cost is negligible. The article emphasizes the amount of material in the motion that can be projected—frog heart beat, twigs covered with scale insects, earthworms, lubber grasshoppers, growing crystals, etc.

—C.M.P.

SHOOP, JOHN E. "Arousing Interest in Senior High School Biology." *The American Biology Teacher* 3:14–17; October, 1940.

Methods used by the author in arousing interest in his New Rochelle, New York, Biology classes include: (1) students given cooperative biology test at beginning of course, in February, and at the close of the school year—growth noted, (2) each student given a reference outline covering the entire year's course, (3) extensive use of biology reference books, (4) formation of student Biology Council and Biology Club, (5) field trips, (6) visual aids, (7) term papers, (8) laboratory experiments, and (9) biology awards.

—C.M.P.

ARENSON, SAUL B. "Lecture Demonstrations in General Chemistry." *Journal of Chemical Education* 17:469–472, 513–515; October, November, 1940.

A series of eleven demonstrations in general chemistry are described. Several of them are applicable to high school chemistry classes or for use in science clubs.

—C.M.P.

DERRICK, J. O. "One Hundred High School Chemistry Projects." *Journal of Chemical Education* 17:492–494; October, 1940.

This article lists not only the name of the project, but also a most pertinent reference where a description of the project may be found.

—C.M.P.

WRIGHT, JACK. "Making Lantern Slides." *Camera Craft* 47:493–497, 557–561, 613–619; October, November, December, 1940.

This article discusses the materials available for lantern slides, the methods of printing such slides, and the problems of exposure and development. Numerous developer formulae are included.

—C.M.P.

ANONYMOUS. "How Music Comes from Sound Waves." *Popular Science Monthly* 137:210–211; November, 1940.

This illustrated article describes a series of simple, interesting experiments in sound.

—C.M.P.

SYMPOSIUM. "Ships and Men." *Building America* 2:34–63; November, 1940.

Ships and Men is a timely discussion of our Merchant Marine and its significance both as a public carrier in times of peace and as an important auxiliary to our defense in times of war. Much factual information and many splendid photographs are included.

—C.M.P.

BARTLE, GLENN G., EKBLAW, SIDNEY E., AND HILKEN, HENRY G. "Conservation of Our Natural Resources." *The Journal of Geography* 39:274–280; October, 1940.

This is a most timely discussion on conservation of fuel resources in the United States.

—C.M.P.

SYMPOSIUM. "We Americans." *Building America* 6:1–30; October, 1940.

This is a study of the refugee and immigration problem in America today. This is a vital problem in our national defense. There are vivid pictures and pertinent textual material.

—C.M.P.

YOUNGHOLM, DAVID S. "The Time Capsule." *Science* 92:301–303; October 4, 1940.

This is an address made at the time of the "sealing-in" of the Time Capsule made at the World's Fair, September 23. An 800 pound capsule was placed in a fifty-foot immortal well—to be opened in 6940. The article lists the various materials placed in the capsule, and the methods used to tell futarians of 6940 how and where to find the capsule.

—C.M.P.

GENERAL EDUCATION

TENENBAUM, SAMUEL. "It'll Come in Handy Some Day!" *The Clearing House* 15:67–70; October, 1940.

This article is an attack on the big alibi of the curriculum die-hards—the "it'll come in handy some day" school of thought in teaching. The author believes that you shouldn't teach way over a child's head and also that the material taught

should be worthwhile now and within his present needs.

—C.M.P.

MONES, LEON. "We Have Abandoned Homogeneous Grouping." *The Clearing House* 15: 76–78; October, 1940.

In the Cleveland Junior High School, Newark, New Jersey homogeneous groupings has been abandoned for "social grouping." The author cites a number of facts in criticizing the old system and justifying the new plan. —C.M.P.

TELLER, JAMES D. "Improving Ability to Interpret Educational Data." *Educational Research Bulletin* 19: 363–371, 390; September 25, 1940.

This is a resumé of a comparative study of two sections enrolled in a course in the College of Education, Ohio State University, during the spring quarter of 1939. Each section consisted of 40 unselected students. In one section, especial attention was paid to the interpretation of data. The experimental group not only showed a greater improvement in their ability to interpret data, but they developed a more critical attitude toward current educational problems than did the conventional group. —C.M.P.

SYMPOSIUM. "Education for Work." *Teachers College Record* 42: 1–76; October, 1940.

This issue of *Teachers College Record* has the above indicated title as its theme. Articles are as follows: (1) Federal Aid in Stimulating Education for Work by Paul V. McNutt, (2) New Developments in Apprenticeship by Edwin A. Lee, (3) Diversified Occupations Program by J. Warren Smith, (4) Training for the Distributive Occupations by Hamden L. Forkner, (5) Work Education on the Junior College Level by Donald P. Cottrell, (6) New Tools for the Vocational Counselor by Harry D. Kitson, (7) Inducting Youth Into Employment by Roy N. Anderson, (8) the Responsibility of the Community by Wilbur C. Hallenbeck and William Pitt, (9) The Program at Richmond, Indiana, by William G. Bate, and (10) Vocational Preparation in a Rural High School by Edgar M. Finck.

—C.M.P.

CASTKA, JOSEPH F. "Modern Chemical Concepts and the High School Curriculum." *Journal of Chemical Education* 17: 487–492; October, 1940.

The purpose of this article is to present, for high school use, some of the available theoretical and experimental material dealing with (1) the electronic theory of matter, (2) the interionic attraction theory of strong electrolytes, and (3) the Bronstead-Lowry acid-base theory.

—C.M.P.

SYMPOSIUM. "Education of Exceptional Children." *The Phi Delta Kappan* 23: 33–78; October, 1940.

This symposium contains the following articles: (1) National Program by Elise H. Martens, (2) A State Educational Program by Frank V. Powell, (3) Organization of a City Program by Christine P. Ingram, (4) Training the Teachers by Charles M. Elliott, (5) Education for Mentally Handicapped by Philip A. Cowen, (6) Selection and Classification of Mentally Retarded, (7) Visually Handicapped by George F. Meyer, (8) Children Who Cannot Hear Well by Josephine B. Timberlake, (9) Education of the Socially Handicapped by Edwin H. Stullken, (10) Education of Gifted and Talented Children by William L. Connor, and (11) the Baltimore Program.

—C.M.P.

TERMAN, LEWIS M. "Psychological Approaches to the Biography of Genius." *Science* 92: 293–301; October, 1940.

The sine qua non of genius is the ability to acquire and manipulate concepts, the shorthand symbols without which abstract thinking cannot proceed. In the first part of the article, Dr. Terman reviews some of the more recent approaches to the biographical study of eminent persons. He points out the tendency for the direction of later achievement to be foreshadowed by the interests and preoccupations of the childhood. A second approach is by the study and follow-up of intellectually superior children. In 1922 the author selected a group of 1,300 superior students for study. A follow-up study was made in 1928 and again in 1939. This article reports several conclusions from this latest study.

—C.M.P.

SYMPOSIUM. "Evaluation and Its Relations to the Program of Teacher Education." *Educational Research Bulletin* 19: 391–420; October 9, 1940.

This issue of the *Educational Research Bulletin* places emphasis upon the program of instruction at Ohio State University which is designed to culminate in the development of competent teachers. Phases considered are: (1) our concept of evaluation, (2) evaluation procedures in the lower division, (3) selection for student teaching and certification, and (4) problems and plans remaining.

—C.M.P.

GEISEL, JOHN B. "Learning With Learners." *School and Society* 53: 9–13; January 4, 1941.

The author is convinced that the best teaching occurs and the most worthwhile learning takes place when the teacher learns and shares experiences with the class. Experience is learning and a reciprocal activity. Every activity can and should constitute a learning experience for the teacher. In that way a teacher never gets in a rut or gets old on the job.

—C.M.P.

SCIENCE

STOKLEY, JAMES. "Five Planets Shine." *Science News Letter* 39: 58–59; January 25, 1941.

On February 20 occurs the concluding stage of a very rare heavenly event. Jupiter will then pass Saturn for the third time since last summer. The first passing (conjunction) took place on August 15 and the second on October 11. Such a series within less than a year is called a triple conjunction. It happened last in 1682–1683. Before that it happened in 1425. It also occurred in 6 B.C. and may have been one of the celestial events attracting the Wise Men. The next occurrence will be about 2197.

—C.M.P.

POUGH, RICHARD H. "American Birds of Prey." *Natural History* 46: A Chart; October, 1940.

This is an excellent chart, showing pictures of the six American birds of prey, their habitat, and a key for identification.

—C.M.P.

PARRAN, THOMAS. "Cancer and Old Age." *The Scientific Monthly* 51: 293–298; October, 1940.

About 50 per cent of cancer cases fall within the age group of 50–69, about one fifth are in the age group 40–49, and one fifth over 70. Thus cancer is a disease predominantly of late adult life, but not exclusively so. The cause or causes of cancer are as yet unknown, but are believed to be within one of the two categories: (1) extraneous and environmental factors, most of which are endowed with properties for producing chronic irritation, and (2) factors inherent in the human host.

—C.M.P.

LATHROP, H. O. "The Struggle for Natural Resources as a Cause of the European War." *The Journal of Geography* 39: 237–242; September, 1940.

A partial reason for the present world war is the struggle for natural resources: minerals, coal, iron, and petroleum. There will likely be future wars having a similar basis.

—C.M.P.

DAVIS, WATSON. "Exploring a New World." *Science News Letter* 38: 227–230; October 12, 1940.

The Radio Corporation of America has developed a new electron supermicroscope that attains direct magnification of 10,000–30,000 with such fine detail that photographic enlargements of 100,000–200,000 are possible! (An ordinary microscope, at best, magnifies about 2,000 times and microscopes using ultra-violet light, about 5,000 times.) It is believed that molecules have been made visible on certain micrograph photographs. The electron microscope retails for $9,500. Possible uses of the new machine seem to be limitless.

—C.M.P.

THONE, FRANK. "New Flavors for Feasts." *Science News Letter* 38: 314–315; November 16, 1940.

Frozen fresh vegetables, meats, and fruits are changing America's diet. These retain their flavor to a much greater degree than they do when preserved by other methods. Tin cans as well as glass jars are now being used. Tradition has it that the method was first applied by Clarence Birdseye to frozen fish.

—C.M.P.

BEEBE, WILLIAM. "Man's Gloomy Friend, the Camel." *Science Digest* 8: 10–15; November, 1940.

This article is condensed from the Bulletin of the New York Zoological Society. The author says if there were no live camels and we knew them only from prehistoric drawings, we would not believe them. The most careful study of the skeleton gives no hint of such a thing as a hump, to say nothing of two. The article explains why camels can go for days without water, although requiring as much as other animals of its size. Horses are peculiarly allergic to camels and to ride a camel gracefully and comfortable is an art.

—C.M.P.

SIMPSON, GEORGE GAYLORD. "Resurrection of the Dawn-Horse." *Natural History* 46: 194–199; November, 1940.

This excellently illustrated article traces the history of the finding of the various fossils which show the evolution of the horse.

—C.M.P.

DARLING, J. RODGER. "Miracle on Wings." *Natural History* 46: 205–207, 240–244; November, 1940.

This is the story of pigeons—trained by prince and pauper from earliest times. Their remarkable accomplishments range from acrobatic exhibits to orderly flights of many thousands of miles. The article describes the family life of pigeons, the characteristics of various kind of pigeons, and how they are trained as homing pigeons.

—C.M.P.

OVERBECK, ALICE O'REARDON. "Tin, the Cinderella Metal." *The National Geographic Magazine* 78: 659–684; November, 1940.

This story of tin is accompanied by twenty-four illustrations. Operations in Bolivia, Malaya, and Cornwall are described and pictured.

—C.M.P.

LOEBER, C. STANTON. "Light Is Everything." *Camera Craft* 47: 545–549; November, 1940.

This article emphasizes the great importance of lighting effects in photography. Three excellent photographs serve to illustrate the point.

—C.M.P.

BALL, W. W. ROUSE, AND COXETEN, H. S. M. "Feats of Lightning Calculators." *Science Digest* 8: 83–89; November, 1940.

At rare intervals youths have appeared who possess extraordinary powers of lightning mathematical calculation. In a few seconds they gave the answers to questions connected with multiplication of numbers and extraction of roots which an expert mathematician could only obtain in a longer time with the aid of pen and paper. Among such remarkable individuals are Colburn of Vermont, Bidder of England, Dase of Germany, and Inaudi of Italy. Numerous examples of their unusual ability are included in the article.

STOKLEY, JAMES. "Oil for Defense." *Science News Letter* 38: 298–299; November 2, 1940.

Oil is playing the part in this World War that coal did in the first World War. Products include explosives, dyes, and drugs. Formerly, refiners extracted about 19 per cent of the gasoline already present in the crude—now due to the cracking process the yield is 44 per cent. The yield could be stepped up to about 90 per cent. About 600,000 gallons of polymerized gasoline are now made daily from petroleum gases.

—C.M.P.

ALLEN, ROSS. "A Snake in the Hand." *Natural History* 46: 234–239; November, 1940.

The author is one of our best known experts on snakes. He has milked about 40,000 poisonous snakes and has never been bitten in the process. He describes the process of capturing poisonous snakes—rattlesnakes, copperheads, cottonmouth, moccasin, and coral snake. The coral snake's venom is the most potent, but being much less in volume the coral snake's bite is not as dangerous as that of other snakes. One of the interesting stories he relates is that of a friend of his who was severely bitten by a diamondback rattlesnake and lived to tell the tale. One of his helpers had a very close call from a copperhead bite.

—C.M.P.

HUBBLE, EDWIN. "Problems of Nebular Research." *The Scientific Monthly* 51: 391–408; November, 1940.

The Observable Region of space is a region some 1,000 million light years in diameter, throughout which are scattered some 100 million nebulae. In every direction there is no evidence of a thinning out, no trace of a physical boundary. The faintest nebulae lie at an average distance of about 500 million light years, however some may be in the order of 1,000 million light years distant. Distance is measured both by Cepheid variables and by red shifts in spectra. About 97.5 per cent of the nebulae show rotational symmetry. Among many problems that have been raised are: (1) determining an accurate distance scale, (2) dynamical aspects of the system, (3) interpretation of supernovae, (4) spiral structures, and (5) meaning of red shifts.

—C.M.P.

Book Reviews

SCIENCE TEXTBOOKS

POWERS, SAMUEL RALPH, NEUNER, ELSIE FLINT, BRUNER, HERBERT BASCOM, AND BRADLEY, JOHN HODGDON. *Using Our World.* Boston: Ginn and Company, 1941. 626 p. $1.76.

This ninth-grade book completes the series "Adventuring in Science." The two previous volumes *Exploring Our World* and *Our World Changes,* have been reviewed in *Science Education.* In this book pupils will learn how man controls and uses his environment. There are five units as follows: "The Living Resources of Earth," "Our Mineral Treasures," "Putting Energy to Work," "The Preservation of Health," and "The Conservation of Wealth."

Simple experiments carefully integrated with the text appear at suitable intervals. There are exercises at the end of each chapter intended to encourage the development of a scientific way of thinking as well as to make provisions for individual differences. A workbook is available.

Numerous, pertinent, excellent photographs supplement the textual material. Many of these are entire pages. The half-page photographs are always found at the top or bottom of the page, and the quarter page photographs at the lower or upper right or left-hand corner. The pictures extend to the margins of the page in all cases. The print is larger than usual and very readable. The color of the paper should relieve eye-strain. Seemingly especial attention has been paid to phraseology and technical vocabulary. The literary style is such as to catch and hold the attention of pupils and in the opinion of the reviewer the one thing that makes the books one of the finest general science texts yet written. The textual material has been carefully selected. The authors are to be commended for their refraining from trying to crowd into the text a super-abundance of material inadequately treated.

From the standpoint of content, pictures, style, interest, and readability, this book will rank high in pupil appeal and will have wide usage.

—C.M.P.

OPPE, GRETA. *Chemistry.* Austin: The Steck Company, 1940. 160 p. $0.36.

This is a combination workbook-laboratory manual. There are eleven units commonly found in most high school chemistry textbooks. This workbook would seem to be adaptable for use with any textbook or series of textbooks. There are 57 laboratory exercises. Undoubtedly this book will appeal to students. The author's many years experience in the classroom are evident throughout as shown by the interesting commentary at the beginning of each unit, the pupil self-tests, things for the pupils to do, suggestions for reading, the thought-provoking questions, the pertinent illustrations, and the easy-to-follow directions. Unit tests accompany each unit. The reviewer is confident that it is far superior to any chemistry laboratory manual or workbook he ever used and should appeal to many present day classroom teachers of chemistry.

—C.M.P.

BROWNLEE, RAYMOND B., FULLER, ROBERT W., HANCOCK, WILLIAM J., AND WHITSIT, JESSE E. *Chemistry in Use.* Boston: Allyn and Bacon, 1939. 678 p. $1.80.

Fundamental principles, operations, and theory are first presented as a basis for the work of the course. Throughout the book, stress is laid upon the everyday applications of chemistry. This book is not a revision of one of the previous books written by the same group of authors.

The book has an attractive appearance, the language is simple, vivid, and appealing, the photographs are clear and distinct, and the textual material seems to be well selected. The last 350 pages or so emphasize the chemistry of daily living. The chapter headings in this part include: "Food for Energy," "Proteins, Minerals, and Regulators," "Milk," "Leavening Agents," "Pure Drinking Water," "Textile Fibers," "Dyes and Dyeing," "Household Cleansing Agents," "Bleaching and Disinfecting Agents," "Building Materials," "Brick, Pottery, and Glass," "Paints, Varnishes, and Lacquers," "Photography," and "Food for Plants."

—C.M.P.

KRUTH, FRANK O., CARLETON, ROBERT H., AND CARPENTER, FLOYD F. *Modern-Life Chemistry.* Philadelphia: J. B. Lippincott Company, 1941. 774 p. $1.80.

Every high school chemistry instructor should be interested in examining the 1941 edition of this up-to-date chemistry book. It is divided into eleven units, each of which consists of discussions of problems. Each problem is followed by summary exercises. The illustrations, consisting of diagrams and photographs, are interesting and well chosen. The material of the text is easily read and should be comprehensible to the average high school boy or girl.

The authors present an authoritative and functional chemistry which can be used effectively in the secondary school. They have attempted to maintain a balance between the theoretical and practical aspects of chemistry so that it meets the

needs of both college preparatory and non-college groups.

Nearly a hundred pages of the book are devoted to organic chemistry, with emphasis on those chemicals which are in common use. In the section called "Chemistry Marches On" are discussions of sulfanilamide, sulfapyridine, synthetic vitamins, gasolines produced by cracking processes, polymerization of artificial rubber from petroleum, modern plastics, and synthetic fibers such as nylon.

This book is recommended as either a text or as supplementary material for high school chemistry classes. —Roy E. Maneval.

EDUCATION BOOKS

SHELTON, H. S. *The Theory and Practice of General Science.* New York: Nordemann Publishing Company, Inc., 1939. 139 p. $1.05.

This is a book from Great Britain. General science has long been a topic for discussion among the British science men, but it is only recently that it has received recognition of Examining Boards. The average teacher of science today does not have a clear idea of the general science movement. This book attempts to explain what it is all about. It emphasizes the abandonment of classification into special science groups but advocates the organization by topics which cuts across the conventional special sciences. One paragraph about the teacher is interesting.

"A little advice to headmasters . . . who have to appoint science teachers will be useful. They will be advised not to worry overmuch about what the teacher knows. What is required is not detailed specialized knowledge of a number of subjects but teaching ability, adaptability, and mental alertness. If a teacher is properly qualified in any branch of science and is a good teacher, that is what is needed. Leave the rest to the teacher."

—W.G.W.

LUTHER HALSEY GULICK, ET AL. The Regents' Inquiry. *Education for American Life.* New York: The McGraw-Hill Book Company, Inc., 1938. 167 p. $2.00.

This report of the Regents' Inquiry in New York State is particularly important because of its implications for education in all of the states and the country as a whole, and because also of its comprehensive consideration of all divisions of our educational organization—elementary, secondary, higher, and adult—and its emphasis upon the vital relations of education inside and outside of formal institutions to the perpetuation and perfection of American democracy.

Part I includes three sections: I. Growing Schools for a Growing World; II. The Schools New York State Wants; III. A New Educational Program.

Part II includes: IV. A Home Rule Method for Improving District Organization; V. Rebuilding the State Education Department; VI. Costs and Economies Under the New Program.

The investigations which were made were used as a foundation for the formulated program suggested—"universal educational opportunity, a democratic and not a class plan of education, character-building education, good teachers, useful and up-to-date schooling, the removal of obstacles to adult education, home rule and freedom in education, and at all times, efficiency and economy." Secondary education seems to be most in need of attention and revision although all levels of the educational process are under analytic scrutiny.

School district reorganization is made the starting point in the reconstruction program—redistricting, provisions for larger, optimum-sized schools, equalization of educational opportunity in all parts of the state—in general a plan for the state as a whole and yet a plan which encourages, as always, local initiative and freedom.

The state department is a second major point of attack with a suggested emphasis upon the subordination of "its administrative activities to its leadership and research activities." Research particularly is made the cornerstone of the new building of the State Education Department. Five divisions of this department are recommended: the law division, research division, public instruction division, advanced and professional education division, and the finance and administrative division. While "making surveys, organizing inquiries, holding meetings, and passing resolutions," are regarded as important, more vital is the need for the formulation of a new program carried into execution through new laws, rules, and orders, and new administrative policies and procedures.

The last section dealing with costs discusses the wise use of the money available for education and suggests eight possible means of reducing costs but adds the following summarization: ". . . the quality of education is not controlled primarily by its cost. Other factors, such as teachers, leadership, programs, and equipment, are of greater importance, once minimum support is available. The element to watch in education in the State of New York now is intrinsic quality, and not the price tag."

The book should be put into the hands of all engaged in educational work.

—A.W.H.

THAYER, V. T., ZACHRY, CAROLINE B., AND KOTINSKY, RUTH. *Reorganizing Secondary Education.* New York: D. Appleton-Century Company, 1939. 483 p. $2.75.

This is the general report of the Commission on Secondary School Curriculum of the Progressive Education Association. It is intended to serve as the general point of reference for the progressive program in secondary schools.

It is to be accompanied by other reports in major instructional areas of the secondary schools. Reports from the areas of science, mathematics, and social studies are now available.

The first two divisions, "theoretical foundations" and "meeting the needs of adolescents in a democracy", covering some 350 pages, clothe a few relatively simple statements of philosophy and of policy in a wealth of unnecessary verbiage. Essentially, the new secondary school is to be built about the personal and individual needs of adolescents. These needs are to be discovered by varying studies of the adolescents themselves.

In spite of statements to the effect that adolescents must live in a complex modern society, there is a consistent refusal to see that schools are operated by social groups as much for the protection of the groups as for the protection and development of individuals. There is also failure to see that ends or purposes for the use of a thing cannot be developed by a study of the thing itself. In this case the proposal is that purposes or goals for adolescent development can be set up by a study of the adolescents.

With the exception of the nebulous section on curriculum construction by the *case group method*, the third division dealing with organization and administration is clear in its presentation and sound in its recommendations. The sections on treatment of subject-matter in the school curriculum and on types of organization for setting up curricula are recommended to all educators, especially are these sections called to the attention of members of the *Progressive Education Association*.

The section on evaluation is suggestive and stimulating, but not specifically helpful to school people searching for satisfactory means of evaluation of the educational product.

—R.K.W.

BUTLER, FRANK A. *The Improvement of Teaching in Secondary Schools.* Chicago: The University of Chicago Press, 1939. 389 p. $3.00.

The improvement of secondary school teaching as the author of this book conceives it is fundamentally a matter of developing a more thoughtful philosophy about it which may be further analyzed into a number of principles to serve as meaningful guide posts. Most of the principles he enunciates are principles of method or might well be enumerated in a book on methods.

Part I states the problem of teaching to make clear what teaching really is. Part II develops five principles relating to: (1) desirable objectives, (2) the unity of learning, (3) the activity concept, (4) activity suited to types of learning, (5) motivation to release pupil energy.

Part III discusses four aspects of classroom procedure which may apply the five principles given in Part II: (a) teacher responsibility, (b) the assignment, (c) questions and questioning, (d) directing pupil study.

Part IV develops the principles of (1) individual differences, (2) diagnostic and remedial teaching, (3) relations of the physical and social environment to teaching.

Part V discusses further essential applications: (a) drill, review, and pupil participation, (b) measurement in teaching, and (c) planning in teaching.

Concrete illustrative material, application exercises, and lists of related readings are noteworthy features.

—A.W.H.

BUTTS, R. FREEMAN. *The College Charts Its Course.* New York: The McGraw-Hill Book Company, 1939. 464 p. $3.00.

An historical account of the evolution of the college and university is given in this book. Broad view points are particularly developed and discussed. The author's conception is that only with a background which recognizes what has gone before in the formulation of the present colleges can administrators and faculty and laymen make intelligent plans for future progress.

In the words of the author, "Part I sketches briefly the origins of the tradition that a liberal education should be predominantly linguistic and literary in character and that such an education can be attained only through a college curriculum that prescribes certain studies.

"Parts II and III show how rapidly changing social and intellectual conditions of the nineteenth century weakened this conception of a liberal education in the American college and gave rise to many innovations among which the elective system was perhaps most representative.

"Part IV indicates the different kinds of proposals and the respective arguments that have been offered in the twentieth century in various efforts to find a remedy for the difficulties that grew out of the elective system and the nineteenth century."

Twenty-two chapters are included and detailed references are made to historical movements, authoritative writers, and interpretative summarizations of points of view and controversial questions.

The last chapter is in the nature of a summary and the setting of a foundation for the future. Its title, "As the Controversies Continue" indicates this purpose of the writer. The sub-headings are particularly pertinent in understanding the core issues involved: "The Great Tradition versus Experimental Naturalism"; "Intellectualism versus Social Intelligence"; "Discipline versus Freedom"; "The Ivory Towers versus the Watchtower"; "Culture versus Cash"; "Aristocratic versus Democratic Conception of the College"; "Traditional Studies versus Modern Studies"; "Religious versus Secular Conception of the College"; "General

Education versus Specialization"; "The Elective System versus the Prescribed Curriculum."

The author is not argumentative in discussion but, for fear that the reader will think he has no opinion on the matter, makes this last conclusive statement: "The final blueprints cannot be given, but the historical evidence would lead this writer to indicate that the appropriate way out of present college confusions lies in the acceptance by educators and laymen of an attitude that is frankly critical, experimental, and progressive."

—A.W.H.

WEISKOTTEN, HERMAN G., SCHWITALLA, ALPHONSE, CUTTER, WILLIAM D., ANDERSON, HAMILTON H. *Medical Education in the United States.* Chicago: American Medical Association, 1940. 272 p. $1.00.

This book on medical education in the United States, 1934–1939, has just been published by the American Medical Association. It contains the report of a survey of medical education in all recognized medical schools in the United States and Canada. Without naming schools, the report describes in general terms the organization and administration, the faculty and student personnel, and the clinical and financial resources of the medical schools. The critical study of medical schools initiated by the American Medical Association in 1901 has had much to do with raising the standards of medical practice and education. The report reveals that medical education costs twice as much as other professions, the instructional cost per student on a credit hour basis in medicine being $26.96. For the most part the schools of medicine have limited their enrolment to students from accredited colleges. Some schools exacted a B average while others demanded an A, but the report says, "It is doubtful how much such requirements mean in the face of the well recognized difference in college grading systems. In the last analysis the admission to medical school must be determined by a study of the individual student's total record. Medicine deserves the best from every point of view including the academic." The book should prove valuable in the field of vocational guidance.

—Greta Oppe.

SHUSTER, CARL N. *A Study of the Problems in Teaching the Slide Rule.* New York: Bureau of Publications, 1940. 103 p. $1.85.

Dr. Shuster has made an excellent analysis of the problems involved in teaching the use of the slide rule. Upon the assumption that an elementary knowledge of approximate computation is necessary for rapid and intelligent use of the slide rule, a clear and concise discussion of significant figures precedes the presentation of the teaching methods. Included also is a study of the various types of errors committed by students and a careful evaluation of the suggested teaching methods to prevent these errors.

—Herman Roth.

SCIENCE REFERENCE BOOKS

BOARDMAN, DONALD C., Editor. *1940 Collegiate Camera Annual.* Wheaton, Ill.: Collegiate Camera Annual Publishing Co., 1940. 111 p. $2.00.

A few years ago an attempt was made to start a photographic exhibit of pictures taken by college students. As a result of this and other subsequent efforts, then was sent out to every college, an invitation to submit photographs for the purpose of publishing selected photographs in an annual publication. The result of this effort was the publishing of Collegiate Camera Annual. The purpose has been the increased interest in Photography and the introduction of courses in the subject in places that did not have them before. As one thumbs through this first volume he is struck by the excellence of the work done. Since this is purely an amateur endeavor, it is a credit to the efforts of the publishers and to the students whose work is here presented.

The publication of this material should serve as an inspiration to other future photographers and as a basis for comparison for those of us who merely try. This publication should be kept as a ready reference and should be in every school library.

—F. L. Herman.

EDGERTON, HAROLD E. AND KILLIAN, JR., JAMES R. *Flash.* Boston: Hale, Cushman and Flint, 1939. 203 p. $3.00.

A great deal of material has been published in recent years about the development of methods of high speed photography. Very little of this material has referred to the actual development and techniques involved in this most modern of scientific equipment. "Flash" is a scientific publication in which the development of methods in high speed photography is traced. The more technical aspects of the subject as they grew from the recognized need are traced by Dr. Edgerton who is one of the foremost proponents of this art. The methods and procedures are carefully and clearly described. The material is completely illustrated. This book is full of applications of high speed photography and illustrated applications in everyday life, in science and in industry. The material is clearly presented. One will find "Flash" easy to read and to comprehend. At the close of the book circuits and parts are included as well as a selected group of references which are valuable to those who contemplate taking up a study of this material.

It is this reviewer's opinion that "Flash" should be placed for ready reference by the

serious worker and layman alike. Its material is adapted for these groups and in high schools and colleges as well.

—F. L. Herman.

JOHNSON, OSA. *I Married Adventure.* Philadelphia: J. B. Lippincott Company, 1940. 376 p. $3.50.

Osa Johnson (Mrs. Martin Johnson) is probably the foremost woman explorer of the world. For twenty years she was the constant companion of her husband, Martin Johnson, probably the most famous explorer of the last two decades. Mr. Johnson once described Osa as follows: "For bravery and steadiness and endurance, Osa is the equal of any man I ever saw. She is woman through and through. There is nothing 'mannish' about her. Yet as a comrade in the wilderness she is better than any man I ever saw." Mr. and Mrs. Martin Johnson encircled the globe six times and spent many years in Borneo and in Africa. The many splendid films the Martins took of animal life in the tropics are a rich heritage that could not be reduplicated.

In this book Mrs. Johnson details the twenty years of their explorations which culminated in the death of Martin Johnson in an airplane crash in California. The book is interesting, fascinating reading from beginning to end. Several hundred thousand copies have been sold and for many months it has been one of the five most popular non-fiction books in demand at public libraries.

—C.M.P.

LYNCH, JOSEPH. *Our Trembling Earth.* New York: Dodd, Mead, and Company, 1940. 202 p. $3.00.

This is a popular account in narrative form of the present knowledge of earthquakes and how this knowledge has been obtained. Earthquakes are discussed with references to their definition, occurrences, location, identification, distances, history, causes, and measurement. Considerable space is given to seismology and its uses. The book is of greater interest because the author described the equipment and instruments that he uses at Fordham University and referred to valuable observations that have been made there. Unfortunately the figures and illustrations are not always most conveniently located and there is considerable confusion in the numbering of the figures.

—H. A. Miley.

ANDREWS, ROY CHAPMAN. *This Amazing Planet.* New York: G. P. Putnam's Sons, 1940. 231 p. $2.00.

This is not a book of popular astronomy nor of physiography, but a collection of natural history tales. The author is the director of the American Museum of Natural History, who needs no introduction to most readers.

The stories are very short. Each one is complete in itself and unrelated to those which precede and follow it. The writing is entirely non-technical.

The book is recommended to adults as pick-up reading and especially to junior high school youths. It will make a welcome addition to high school science libraries.

—R.K.W.

BAKKE, E. WIGHT. *The Unemployed Worker; Citizens Without Work.* New Haven: Yale University Press, 1940. 465 p.; 311 p. $4.00; $3.00.

These are companion volumes published for The Institute of Human Relations. It presents the results of a series of studies that have been carried on at the Institute of Human Relations since 1932. *The Unemployed Worker* is a study of the task of making a living without a job. It portrays the normal "world of labor" in which the worker lives and the socially approved resources he has developed for meeting his problems. It is the analysis of unemployment and its effects in an American community (New Haven, Connecticut). Several sources and methods of acquiring information were used: (1) participation as unemployed men in the life and practice of the unemployed for several periods during the eight-year interval of the study, (2) intensive case studies of twenty-five unemployed families, (3) interviews with 200 families of unemployed, (4) interviews with social workers, ministers, public officials, and employers, (5) examination of numerous reports and documentary evidence, and (6) investigation of a 10 per cent sample of unemployed having unemployment compensation.

Citizens Without Work is a study of the effects of unemployment upon the workers social relations and practices. The final section of this book is a summary of the findings of both volumes focused on two questions: Has the alleged decay of self-reliance among the unemployed actually occurred? What tests for effective social services are suggested by the conclusions of this study? Unemployment and work-relief are a definite challenge to self-reliance. A general conclusion is "that men shall have sufficient economic resources so that some unforeseen event doesn't hurl them into an economic abyss is a necessary foundation for ambition."

All persons vitally interested in social problems, and problems of unemployment and relief will find these two volumes rich in data and implications. Science teachers and curriculum workers believing in the social functions of science will find here much food for thought.

—C.M.P.

BAITSELL, G. A. *Science in Progress.* New Haven: Yale University Press, 1940. 317 p. $4.00.

Here, brought together under one cover, is a survey of ten important frontiers in the advancement of science. Ten leaders in research,

chosen to give the National Sigma Xi Lectures in 1939 and 1940, have published their papers and illustrations. The fact that these were given before Sigma Xi Clubs and Chapters throughout the nations, places these chapters upon a high plane. The editorial work is excellent. The scientific work is not worked behind a laborious literary style. Here the literary effort is comparable to the extensive scientific achievements. The chapters and their authors are: L. J. Stadler—The Experimental Alteration of Heredity; F. W. Went—The Regulation of Plant Growth; J. F. Fulton—Experimental Studies on the Functions of the Frontal Lobes in Monkeys, Chimpanzees, and Man; Douglas Johnson—Mysterious Craters of the Carolina Coast, A Study in Methods of Research; Alfred C. Lane—How the Earth Shows Its Age; H. P. Robertson—The Expanding Universe; Carl D. Anderson—Cosmic Rays and New Elementary Particles of Matter; Duncan A. MacInnes—The Motions of Ions and Proteins in Electric Fields; J. W. Beams—The Ultracentrifuge; J. C. Hunsaker—Recent Advances in Aeronautics.

Each chapter is supplemented with references to reviews and papers within the various fields. A thirteen-page index completes the book.

—Herman Roth.

WERKMEISTER, W. H. *A Philosophy of Science.* New York: Harper and Brothers, 1940. 551 p. $4.00.

This philosophy of science has two major objectives: (1) the establishment of an epistemological point of view and (2) the integration of the various fields of knowledge. A critical analysis of the fundamental tenets of classical mechanics prepares the ground for a definite epistemic point of view which is then applied to natural languages, mathematics, relativity, quantum and wave mechanics, chemistry, biology, psychology. Emphasis is placed upon a thorough understanding of the essential facts of the various sciences, and an integration of modern interpretations of matter, life, mind, and personality.

—C.M.P.

GERARD, R. W. *Unresting Cells.* New York: Harper and Brothers, 1940. 439 p. $3.75.

Do you have a clear mental picture of the atomic structure of a molecule of sugar, of fat, of protein? Do you visualize clearly the make-up of protoplasm, the arrangement of molecules in a cell wall? What is the nature of an enzyme and how do the various enzymes work, not in general, but specifically? Do you have a clear cut idea of what is transpiring in a nerve fiber when it is transmitting an impulse, in a muscle fiber when it contracts? What does growing old really mean? What is it that is transmitted in the genes? Here is a book that by clever diagrams and lucid word pictures tells you what the modern biologist thinks about such matters. It gives, too, the experimental evidence that supports the conclusions. It is a fine piece of work—a volume that helps clarify life processes. It gets below the surface and sets one thinking in terms of the essentials. It is highly recommended.

—E.R.D.

HALDANCE, J. B. S. *Adventures of a Biologist.* New York: Harper and Brothers, 1940. 281 p. $2.75.

Printed in England, 1937, under the title "Keep Cool," this book is a collection of essays, published originally in several magazines. There are twenty-seven of them. The adventures are intellectual, though the author has also been physically venturesome, on several occasions being his own guinea pig. Darwin, Blood Royal, What is Religious Liberty, Biology and Town Planning, the Marxist Philosophy, are sample titles that indicate how varied are the subjects treated.

Blood Royal shows how Queen Victoria transmitted haemophilia to some of her male descendants. A Biologist looking at England relates how certain characteristics of Englishmen are traceable to climate, soil and racial admixtures. Such are the essays. They are all interesting, sprightly, as would be expected from so virile an individual. The book has no unity except as it expresses the personality of the author.

—E.R.D.

CASSON, STANLEY. *The Discovery of Man.* New York: Harper and Brothers, 1939. 337 p. $3.00.

In the preface the author states that this is not a history of archaeology and anthropology—that would require several volumes. It is a sketch of the work of certain men of vision and brilliance whose contributions have particularly advanced these subjects. His story goes back to the Ionian Greeks, shows how there followed a decline of curiosity regarding human beginnings, then a revival with the discovery of the New World, and an intense interest as great discoveries were made of several ancient but forgotten civilizations and of fossils of palaeolithic and eolithic man.

Among the conspicuous contributors in the field of anthropology are Herodotus, its father, William Stukeley, famous for his studies of Stonehenge and Avebury circle, John Frere (1797) in England and Boucher de Perthes (1838) in France who recognized the numerous flints as tools of humans and their great age as evidenced by their position in the strata, Charles Darwin, Benjamin Ufarnson, collector of eoliths. Little is said of the discoveries of the skeletal remains of early man.

In the field of archaeology conspicuous places are given to Cyrac of Ancona (1391), father of this science, Garcilasso de la Vege, a Peruvian whose book on the origin of the Uncas was published at Lisbon in 1617, Jean Francois

Champollion, discoverer of the key to Egyptian cuneiform inscriptions, Sir Arthur Evans, excavator of ancient Greece, Alfred Maudsley of Maya fame, Sir Flinders Petrie, Henry Rawlinson, Heinrich Schliemann.

On the whole the book is excellent. It is unduly verbose in spots. Familarity with the contributions of his fellow countrymen gives the English the lion's share of the credit for important discoveries. But the book does not pretend to be an impartial history. It does well what it undertakes to do.

—E.R.D.

WISSLER, CLARK. *Indians of the United States.* New York: Doubleday, Doran and Company, 1940. 319 p. $3.75.

This is the first volume in a new science series sponsored by the American Museum of Natural History. Mr. Wissler is Dean of the Scientific Staff.

Part I briefly traces the rise of the several types of Indians—the pioneer, the stone boilers, the farmers, the builders. Part II (185 p.) classifies the more than 200 tribes into eight families based on linguistic similarities. It tells how each family lived, dressed and gives its customs and history. Part III (50 p.) deals with Indian life in general.

The Indian population is placed at about a million when Columbus came. The average tribe was, therefore, small. A village consisted of about a hundred people. It will surprise most readers to learn that there were such great differences, country over, in dress, occupations, mode of life, customs and outlook.

The heroic but futile defense of their native land against the white invaders is tragedy that the white man now reads with anything but pride. The book is well written, full of interest and gives the reader a sympathic account of these early Americans.

—E. R. D.

FENTON, CARROLL LANE AND FENTON, MILDRED ADAMS. *The Rock Book.* New York: Doubleday, Doran and Company, Inc., 1940. 357 p. $6.00.

The first named author will be remembered for his earlier *Our Amazing Earth.* In this book, which he has written in collaboration with his wife, he offers a popular, authoritative book on rocks of the world. There are five pages in full color, forty-eight pages of photographs and forty line drawings.

Man builds rocks into houses, burns them for warmth, takes metal from them, uses them to make medicine, dyes, ornaments, and even for flavoring his food. The rocks tell him something about how the earth came to be, traces its history through ancient granites rising to form continents and through crumpled rocks that tell of mountain systems that have worn away, and that rocks outside of the earth have the same composition as those found on earth.

This is not only a practical book but one also filled with many interesting stories. There is a particularly useful chapter on rock-hunting and collecting. This book is recommended to all science teachers: elementary, secondary, and college teachers of physical science survey, and geology courses.

—C.M.P.

MORGAN, ALFRED. *Getting Acquainted with Radio.* New York: D. Appleton-Century Company, 1940. 285 p. $2.50.

Here is a new book on the radio written for the average person by this well equipped author who knows so well how to write books on science for the reading of laymen.

The first part of the book is devoted to the development of the radio, the great "adventure in space," of a changing world brought about by waves which have broken down barriers of remoteness and shortened distances all over the earth. Although more than four decades have passed since the first "wireless" message flashed through space, radio communication is carried on by utilizing the same basic principles employed by Marconi. These Mr. Morgan explains to his readers in his own interesting way and then turns to electricity and the science called physics that the experimenter with radio may become proficient at building and know the "hows and whys" of the various parts used in radio circuits. He explains the receiving of radio messages and proceeds to take the "mystery" out of tuning. An entire chapter is devoted to the building of simple radio receivers. The remaining chapters are concerned with transmitting and learning to operate radio transmitting stations. There are some twenty pages devoted to abbreviations and definitions peculiar to radio.

—Greta Oppe.

TURNER, P. K. *Photographic Exposure.* New York: Pitman Publishing Corporation, 1940. 146 p. $1.75.

There has been a very great need for a complete yet simple, accurate treatment of the subject of exposure in photography. Both experienced amateur and the beginner realize the value of knowing the factors involved in making a photographic exposure and the influence which each of these factors have upon one another and upon the finished product. *Photographic Exposure* does just this in a clear-cut manner. Such factors as the nature of light and its behavior, the character of the emulsion, the kind of light and a complete treatment of exposure meters are very carefully and fully treated. This reviewer feels that this small book is a valuable book to have around for ready reference. It certainly should be a part of every library of schools in which photography is taught.

—F. L. Herman.

DUNN, CARLETON E. *Natural Color Processes.* Boston: American Photographic Publishing Company, 1940. 232 p. $2.00.

A great many articles and books have been written on the art of color photography. The enormous increase in the interest in amateur photography has naturally lead to a demand for pictures in natural color. This desire to render the colorings in nature in their true colors has been the driving force behind a multitude of experiments leading toward this end. In this little book the most important of the modern processes are discussed. Included in the book is a practical treatment of the various color processes which the amateur can do for himself. There are twelve sections in the book which are: (1) Simple Color Analysis, (2) Making Color-Separation Negatives, (3) Auto-type Trichrome Carbro, (4) Belcolor Printing film, (5) The Chromatone Process, (6) Reliefs and Inhibition for Color Prints and Transparencies, (7) Duxochrome and Colorstil Color Printing Filius, (8) Dye Mordanting, (9) Screen Color Transparencies, (10) Dufaycolor, (11) Multilayer Color Processes, (12) The Finlay Process.

The directions follow the manufacturer's specifications and there are occasional simplifications of these directions. The book is of value to every one interested in photography and especially to the person desiring to work with color.

—F. L. Herman.

MCDONALD, LUCILLE SAUNDERS. *Jewels and Gems.* New York: Thos. Y. Croswell Company, 1940. 288 p. $2.00.

Mrs. McDonald, as a child, wished by some miracle to be transported on a magic carpet to far-away lands. This urge grew and the day came which was the beginning of more than ten years of travel outside the United States. One day in South America she had an unforgettable experience with gems and jewels and then began a search for "earth's bright treasures."

In this exquisitely written and illustrated book, the author takes the reader into the "valley of diamonds," through "crystalline mountains" to the "kingdom of rubies," as well as to many other jewel kingdoms, concluding with "treasure in America."

We are told how kingdoms have been lost, royal families overthrown, and how pirates sailed the seas to possess percious stones; thus the book is not only about the jewels and gems themselves but includes stories about these precious treasures since earliest times.

—Greta Oppe.

EDDINGTON, SIR ARTHUR. *The Philosophy of Physical Science.* New York: The Macmillan Company, 1939. 223 p. $2.50.

Sir Arthur Eddington, Plumian Professor of Astronomy and Experimental Philosophy at Cambridge University presents the substance of the Tarner Lectures delivered in the spring of 1938. Eddington (in his preface) contrasts the point of view of science, prevalent in 1928 with that of the present by expanding the title of this book with one written eleven years ago.

"The title of the earlier book, *The Nature of the Physical World,* might have been expanded into 'The Nature of the physical universe with applications to the theory of physical knowledge'; the corresponding title of the present book would be, 'The Nature of the physical knowledge with applications to the physical universe.' The change of emphasis . . . reflects a change which has occurred in the physical sciences . . . during the intervening years."

Eddington contends that as a result of the acceptance of the operational point of view in science, which he accepts as the first axiom of epistemological science, science is "selective." Further, since the scientist requires some "a priore" information concerning the nature of the phenomena he wishes to observe in order to adequately design apparatus, our knowledge becomes subjective. Thus, in this sense, our knowledge becomes "Selective Subjective."

Without question, while many will disagree, the philosophy presented by Eddington, represents results of the ultimate purpose in the application of the scientific method, critical self-analysis. Rather than accept a rather smug point of view, of objectivity, Eddington analyzes rather carefully and completely the nature of our knowledge. The conclusions will not be pleasant for those who have maintained the objectivity of science as a fetish. However, there can be no compromise. His philosophy is direct consequence of the operational point of view.

—Herman Roth.

COLBY, MERLE. *A Guide to Alaska.* New York: The Macmillan Company, 1939. 427 p. $3.00.

This *Guide to Alaska* is a Federal Writer's Project publication, but is much more than a conventional guidebook, or travel book. It does explain what a travler needs to know—how to get there, the main travel routes, accommodation, climate, sport and recreation facilities, and approximate fares and living expenses. The first third of the book introduces Alaska—its history, development and natural resources. The second two-thirds of the book describes the major towns and places of interest in such an order that the traveler may use these chapters as a guide along his route. The book is an interesting one for the prospective Alaska traveler, actual or vicariously, for geography teachers, and for all readers interested in far-away places.

—C.M.P.

No. 4

ace of
spring
trasts
1928
e title
s ago.
ure of
panded
with
knowl-
resent
ysical
l uni-
eflects
al sci-
."
of the
ew in
om of
ctive."
ne "a
of the
o ade-
ecomes
wledge

agree,
repre-
in the
l self-
smug
nalyzes
ure of
not be
he ob-
, there
direct
ew.
Roth.

York:
$3.00.
Writer's
than a
It does
how to
mmoda-
es, and
. The
ka—its
s. The
es the
uch an
hapters
n inter-
raveler,
ers, and
ces.
M.P.